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Abstract
The 2015 series of RIO Country Reports analyse and assess the policy and the national research and innovation system developments in relation to national policy priorities and the EU policy agenda with special focus on ERA and Innovation Union. The executive summaries of these reports put forward the main challenges of the research and innovation systems.

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Foreword

The report offers an analysis of the R&I system in Israel for 2015, including relevant policies and funding, with particular focus on topics critical for EU policies. The report identifies the main challenges of the Israeli research and innovation system and assesses the policy response. It was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The quantitative data is, whenever possible, comparable across all EU Member State and associated countries reports. Unless specifically referenced all data used in this report are based on Eurostat statistics available in February 2016.

Acknowledgments

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Executive summary

The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites, etc. The quantitative and qualitative data is, whenever possible, comparable across all EU Member State reports.

The political context in Israel in 2015, which was marked by the early elections for the 20th Knesset (Israeli parliament), held in Israel on 17th March 2015. Prime Minister Netanyahu was re-elected and formed a new government.

The two main Research, Development and Innovation (RDI) bodies -- the Council for Higher Education (CHE) through its Planning and Budgetary Committee (VATAT in Hebrew), and the Israel Innovation Authority (Office of the Chief Scientist (OCS)) in the Ministry of Economy– charged with making and executing research and innovation policy respectively – have different missions and traditionally have cooperated only on an ad hoc basis. However, an increasing number of programs are being launched in tandem by both agencies or by the OCS and the Finance Ministry. The main change in the innovation systems has come from a change in the OCS, which led a recent comprehensive strategic process that examined how to adapt to the dynamic reality. This process was adopted and approved by the Israeli government by government decision number 2092 to establish the Israel Innovation Authority, and aims to further boost research and development (R&D) activities and foster technological innovation in the economy. The new organization is the result of closer collaboration between the Ministry of Finance and the Ministry of Economics, and aims to offer a more flexible environment towards its customers.

The situation is complex for the high-tech industry in Israel. On the one hand, 2015 was a record year fund raising, and on the other hand, this year we have seen decreasing indices in the manufacturing sector. Monitoring these trends, and distinguishing between the characteristics and needs of start-ups versus large and medium sized established companies is essential to innovation policy in Israel, and is seen as the best way to move the country towards a more mature and integrated industry.

In terms of public investments in R&D, Israel seems to be recovering from the effect of the economic crisis. GERD (Government Expenditures in Research and Development), measured as a percentage of the Gross Domestic Product (GDP), has been rising since 2011 from 3.97% that year to 4.09% in 2014. This highlights the recovery of the research and innovation system from the global financial conditions in 2008, which stems from the very high share of business in funding R&D. However, total GERD figures relate only to civilian R&D, as there are no unclassified data on the total expenditure of the large defense-related R&D system. The government has never set out specific targets for R&D expenditure, and is unlikely to do so in the future. Israel is a highly innovative country, well above the EU average for the majority of the R&D indicators. Indeed, its level of innovation performance places it among the group of European "innovation leaders". Only Sweden, Switzerland and Finland show higher levels of innovation performance. Israel is ranked second (to the United States) worldwide in terms of venture capital availability, thus ensuring the right conditions for highly innovative small companies across all sectors (European Commission, 2013).

Israel is also a highly knowledge-intensive country. It has a strong and dynamic academic sector and has achieved excellence in scientific and technical education and research. In 2013, for example, the number of publications per thousand of the population was 2.04 while the average for the EU was 1.43. Moreover, the percentage of publications in the top 10% journals in 2010 was 14.44 compared to 12.25 for the EU average. The share of private-public collaborations for 2011-2013 is twice as high as the EU average, a remarkable difference.

In terms of ERA (European Research Era) and Innovation union objectives the report analyses each of the pillars, and in general finds that the country is moving towards these objectives. For all the

objectives the government or the public institutions are presenting plans to improve in each of them.

It is fortunate that there is an increased level of policy coordination because the Israeli RDI system faces three major structural challenges that require systematic solutions. These structural challenges are as follows:

1. Reviving research in Israeli universities: Budgets for Israeli universities essentially stagnated during the first decade of the century despite a growth in the number of students, thus causing a decline in bibliometric scores.
2. Over-reliance on ICT: Companies dealing with computing and communications technologies are one of the mainstays of the Israeli economy. However, the period of explosive growth for ICT is over and policymakers have been trying for a number of years by various means to find new engines of growth.
3. State of Venture Capital: Returns on VC investments in Israel match returns in the US, where results have been disappointing.

Israeli innovation governance does not have a tradition of formally articulating priorities as part of an open policy-making process. The priorities of the OCS are: new funding sources for the industry, help for start-ups to become mature firms, integration of traditional and public industries in the high tech sector, and identification of systemic challenges in the Israeli innovation system.

EXECUTIVE SUMMARY IN HEBREW

השוואה בני , שניתן ככל הם, והאיכותיים הכמותיים וכו'. הנתונים אינטרנט אתרי ,הערכה דוחות ,סטטיסטיים האירופי באיחוד החברות המדינות דיווחי כל בין.

17 ב שנערכו - 20 (ה לכנסת מוקדמות בחירות ידי על בשנת 2015 אופיינה מבחינת ההקשר הפוליטי: ישראל מייצגת החדשה והקואליציה שינוי בעד הצביעה ישראל אוכלוסיית כי הראו הבחירות במרץ 2015). תוצאות לכיוון הימין תנועה.

הוועדה באמצעות ג)"(מל גבוהה להשכלה המועצה הממונים על מחקר ופיתוח, הגופים העיקריים בישראל שני לפועל והוצאה עוסקים בביצוע משרד הכלכלה והתעשייה, של הראשי המדען ולשכת לתכנון ותקצוב (ות"ת) של מדיניות מחקר וחדשנות (בהתאמה). לשניהם הגדרות משימה שונות והם בדרך כלל משתפים פעולה רק במקרים נקודתיים. עם זאת, ישנה עלייה במספר התכניות החדשות אשר מושקות בשיתוף שני הגורמים או על ידי הראשי, מכיוון המדען מגיע החדשנות במערכות העיקרי לשכת המדען הראשי בשיתוף עם משרד האוצר. השינוי זה תהליך הדינאמית בתעשיית החדשנות. למציאות להסתגל כיצד ניתן ובדק מקיף, אסטרטגי מהלך הוביל אשר הלאומית הרשות , ובמסגרתו הוקמה2092ממשלה מספר בהחלטת ישראל ממשלת ידי ואושר על אומץ ולטפח והפיתוח המחקר פעילות את לחדשנות.מטרת הרשות, אשר תחליף את לשכת המדען הראשי, להגביר ומשרד האוצר משרד בין עמוק פעולה שיתוף בכלל המשק. הרשות החדשה הינה תולדה של טכנולוגית חדשנות לקוחותיה, חברות התעשייה עבור יותר גמישה סביבה רשות החדשנות מכוונת להציע .הכלכלה.

באקזיטים ובגיוסי כספים של שיא שנת הייתה 2014 אחד, בישראל. מצד טק-ההיי בתעשיית מורכב המצב המאפיינים בין ואבחנה אלו, מגמות ניטור .הייצור ענפי במדדי ירידה זו ראינו בשנה שני, ומצד ההיי-טק חברות החדשנות למדיניות חיוניים והבינוניות הינם צעדים החברות הגדולות לעומת אפ-סטארט חברות של והצרכים ובוגרת. משולבת יותר תעשייה לקדם במדינה ביותר הטובה שזוהי דרך בישראל ונראה

הכלכלי. אחוז ההוצאה על המשבר מהשפעת מתאוששת ציבוריות במו"פ, נדמה שישראל השקעות של במונחים של ההתאוששות את מדגישה עלייה זו 2014.בשנת 4.09% ל 3.97% מ 2011 מאז מו"פ מהתוצר עלה מצד המגזר העסקי של השקעה מאוד גבוה מנתח נובעת אשר העולמי, המשבר פיננסי מתנאי החדשנות מערכת ופיתוח מחקר למימון.

על הכוללת המשמעותית ההוצאה על מסווגים נתונים אין שכן אזרחי, ופיתוח למחקר ורק אך נתון זה מתייחס והיא פ"ההוצאה על מו לגבי מידת ספציפיות מטרות הצהירה על לא מעולם מו"פ מצד מערכת הבטחון. הממשלה האירופי ברוב האיחוד ממוצע מעל הרבה חדשנית, מאוד מדינה היא בעתיד.ישראל זאת לעשות צפויה גם לא . האירופיות "בחדשנות המובילות " קבוצת בין אותה מציבה החדשנות ביצועי של רמה זו מדדי המו"פ. ואכן, (השני בעולם במקום מדורגת ישראל .חדשנות ביצועי של יותר גבוהות רמות מראות ופינלנד שוויץ שוודיה, רק סטארטאפ קטנות חברות עבור נוחים תנאים מובטחים בה ובכך,סיכון, הון זמינות מבחינת) הברית אחרי ארצות 2013). האירופית, המגזרים (הנציבות מכל

וטכני. מדעי ובמחקר בחינוך מצוינות שמשיג ודינמי חזק אקדמי ידע. יש בה מגזר עתירת מדינה היא ישראל האיחוד של הפרסומים על 2.04 לכל אלף נפשות בישראל. זאת בעוד שהממוצע עמד מספר2013 בשנת 14.44 היה 2010 ב המובילים בעולם העת בעשירון העליון של כתבי הפרסומים אחוז1.43. הוא האירופי בין אותה מציבה חדשנות בביצועי ישראל של הכללית הרמה, אכן, .האירופי באיחוד בממוצע 12.25 לעומת הוא 2011-2013 לשנים שיתופי פעולה בין המגזר הפרטי לציבורי של החלק .האירופיות " החדשנות "מובילות ראוי לציון האירופי - הבדל באיחוד מהממוצע פי 2.

ובאופן התווך, מעמודי כל אחד מנתח ח"הדו תחומי החדשנות האירופיים ויעדי איגוד החדשנות, של במונחים תוכניות מציגים הציבור מוסדות או הממשלה המטרות בכל .הללו המטרות לכיוון נעה ישראל כי מגלה כללי לשיפור.

שלושה בפני עומדת הישראלית המו"פ שמערכת מכיוון מדיניות היא חיונית ביותר תיאום של המוגברת הרמה : להלן פירוט האתגרים.שיטתיים פתרונות הדורשים גדולים מבניים אתגרים

השמרים על קפאו למעשה הישראליות לאוניברסיטאות התקציבים :בישראל באוניברסיטאות המחקר 1. החייאת ברמת הציטוטים וזה גורם לירידה הסטודנטים הצמיחה של כמות למרות המאה של הראשון בעשור.

המשק של התווך מעמודי אחד הם ותקשורת מחשוב בטכנולוגיות העוסקות : חברות ICT על יתר הסתמכות 2. שנים מספר מזה מנסים המדיניות , וקובעי עברה ICT עבור הצמיחה הגדולה של התקופה זאת עם .הישראלי חדשים צמיחה מנועי למצוא.

היו התוצאות שם,ב,"לארה בהשוואה נשאו תשואה דומה בישראל סיכון הון השקעות :סיכון הון מדיניות . 3 מאכזבות.

פתוח. מדיניות קביעת מתהליך כחלק רשמיים, עדיפויות סדרי של מסורת אין הישראלית, החדשנות למדיניות חברות בלהפוך עזרה ,לתעשייה חדשים מימון הוא: יצירת מקורות הראשי המדען לשכת של העדיפויות סדר מסורתיות תעשיות שילוב ,לבוגרות

1. Overview of the R&I system

1.1 Introduction

Israel is a small country with a population of 8.46 million as at the end of 2015. The GDP per capita reached €28,655 in 2014, and the GDP growth reached 2.8% in 2014. In 2014, the economic growth rate was moderate, compared to 3.3 % in 2013. This slowdown in growth began in the middle of 2011 and a further slowdown was recorded at the end of 2014. The moderation continues the trend that became apparent last year, because the background conditions for economic activity remained similar. This moderation is the result, first and foremost, of the slowdown in demand from abroad. On the real side, this slowdown is reflected mainly in stability in exports and investments, while on the nominal side, it is reflected in the low inflation environment. Excluding the contribution of natural gas production, growth in 2013 was moderate relative to last year, with a number of domestic factors contributing to this (Bank of Israel, 2013a).

The unemployment rate in Israel is low as a result of long term processes that have enabled the labor market to respond relatively quickly to changes in the economic environment and have acted to reduce structural unemployment. The increase in the population's education level has improved the matching of the qualifications of those looking for work with the requirements of vacant positions, while changes in the search process contributed to a decline in the frictional component of unemployment. As a result, the duration of the search has been shortened among both employers and the unemployed. The level of employment in export industries is more volatile than in domestic-market oriented industries, but the personal employment situation in export industries is more stable than in the rest of the business sector (Bank of Israel, 2013b). Moreover, a significant effort is being made to integrate the Arab and Ultra-orthodox populations into the labour market (see section 5.3).

The developments in the economy remained positive this year relative to the situation in other advanced economies. Per-capita growth was higher than the EU average, as in recent years the unemployment rate remained low and the current account surplus was maintained. The economy continued to grow, despite the serious shock from abroad which it absorbed in 2011, mainly thanks to the stability of the financial system and the accommodative monetary policy.

The global environment of moderating economic activity, and particularly low monetary interest rates in major advanced economies, were the main background factors affecting economic activity and policy decisions this year. The growth rate of world trade remained stable and low this year, constraining the expansion of exports.

These developments, together with the slowdown in growth in both advanced and emerging economies, have acted to slow growth in investments in Israel. In contrast, the accommodative monetary policy adopted by the central banks of advanced economies including Israel supported private consumption by lowering the cost of credit and by increasing the prices of the assets held by the public.

Table 1 Main R&I indicators 2012-2014[1]

Indicator	2012	2013	2014	EU average
GDP per capita	30,454.38	32,415.79	32,061.56	27,300
GDP growth rate	3.4 (%)	3.3 (%)	2.8 (%)	1.4(%)
Government debt as % of GDP	69.6(%)	68.3(%)	67.5(%)	86.8(%)
Unemployment rate as percentage of the labour force	6.9 (%)	5.8 (%)	5.6 (%)	10.2(%)
GERD in €m	8498.12	9217.42		
GERD as % of the GDP	4.13(%)	4.09(%)	4.11(%)	2.03(%)
GERD (EUR per capita)	1045.67	1031.25		514.5
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	4.7(%)	4.56(%)	4.36(%)	5.6(%)
Employment in knowledge-intensive service sectors as share of total employment				39.2(%)
Turnover from innovation as % of total turnover	28(%)	n.a.	n.a.	11.9(%) (2012)
Value added of manufacturing as share of total value added	21.0 (%)	20.0 (%)	20.0 (%)	15.53%
Value added of high tech manufacturing as share of total value added	9.9 (%) (%)	4.79 (%)	4.61 (%)	3.2 (%) (2012)

Research and innovation are central pillars of the economy. In 2014 GERD reached 4.11% of GDP compared to the EU average of 2.03% in the same year, with the business sector playing a major part in funding R&D. The share of employment in high-tech and medium-high tech manufacturing sectors for 2014 was 4.36% below the average of Europe that year, which was 5.6%. In contrast, in 2014 the contribution of value added for high-tech was 4.61 %, above the European average of 3.2%. for the same year. The share of turnover from innovation compared to total turnover was 28% for 2012, more than twice the average of the EU for that same year, which was 11.9%.

Thus Israel is well above the EU average for the majority of the R&I indicators (European Commission, 2013). Indeed, as mentioned earlier, its overall level of innovation performance places it among the group of European "innovation leaders". PCT patent applications per billion there was an average annual decrease of 1.43% over the period 2000-2010).

[1] Data provided from the Israeli Central Bureau of Statistics (June 2016)

1.2 Structure of the national research and innovation system and its governance

1.2.1 Main features of the R&I system

Israel is a small country, and its innovation policy is not centralized but distributed across different ministries, while regional authorities play a marginal role. The Israeli innovation system is a dynamic one, with a large investment in R&D mostly from private funding and almost half of it coming from foreign investors.

Israel has an active start up sector and the High Tech industry is particularly dynamic, especially in some sectors like ICT. All important multinationals in this sector have research labs in Israel: Google, IBM and Microsoft.

The industrial dynamic sector is combined with a vibrant academic environment, which fosters the creation of new knowledge in a wide variety of topics. Collaboration and links are frequent, and successful innovations come to the market every year out of these collaborations, while the number of publications per capita is among the highest in the world. All this makes Israel a world leader in innovation, and hence this is reflected in any international ranking.

1.2.2 Governance

The main players in Israel's national research and innovation system, which are responsible for policy-making and governance, are the Office of the Chief Scientist (OCS) in the Ministry of Economy, which is responsible for industrial R&D, and the Planning & Budgeting Committee (known as VATAT) of the Council for Higher Education, which covers academic R&D. However, since 2011, the Ministry of Finance, the ultimate source of funds for R&D initiated by the government and academy (GBAORD and HERD respectively), has become much more involved in innovation policy making. The heightened involvement of the Finance Ministry has helped increase the cooperation and coordination between all entities involved in innovation policy, including the OCS and VATAT.

A lesser player both in budget and influence is the Ministry of Science, Technology and Space, which funds some small thematic research centres, runs 10 small regional research centres and is responsible for some aspects of international scientific cooperation. Under the Ministry's aegis is the National Council for Research and Development, a body that has statutory authority to devise policy and advise the government, but which has proved largely ineffective in recent years.

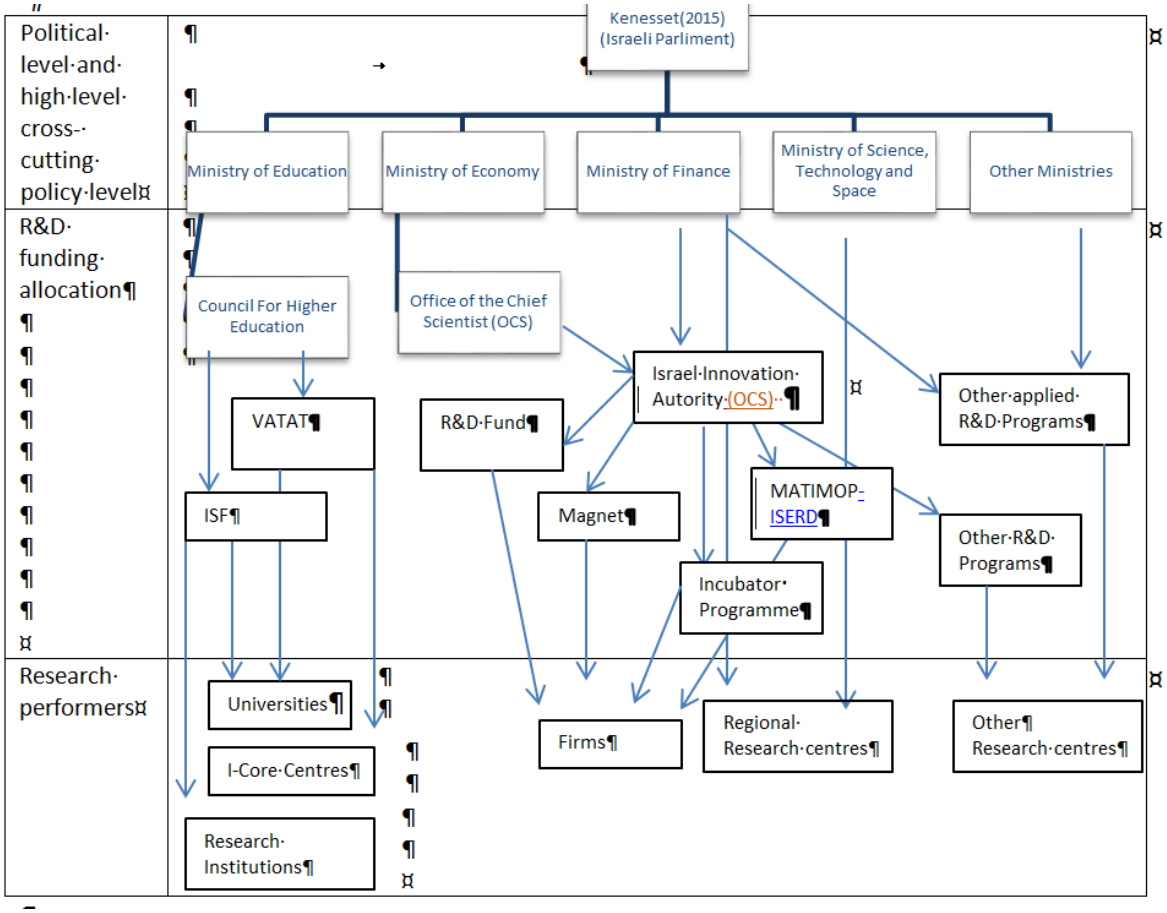
In June 2015 the Economic Minister, Aryeh Deri, and the Finance Minister, Moshe Kahlon, submitted a proposal to establish the Israel Innovation Authority. The government approved the minister" proposal to establish the authority, which will function as the executive arm of the OCS at the Israeli Ministry of Economy and Trade.

The government's innovation policy aims at achieving broad national goals in the coming decade, including: encouraging the growth of industrial companies, injecting technological innovation into traditional fields which are not traditionally R&D dependent, strengthening research infrastructure as well as capital and labor, harnessing innovation for the improvement of the public sector and increasing the participation of sectors currently under-represented in the hi-tech work force. In light of the great importance of innovation in Israel, which in recent years has become the main engine of growth for the Israeli economy and a source of national pride, the government's capabilities must be improved, via a structural change to the OCS which is intended to bring about improved operational capabilities for Israeli industry. The structural change is designed to enable the government to continue to determine its policies in this field.

Establishing the authority will reinforce the government's long-term goals for the hi-tech industry, namely, maintaining and even increasing Israel's global leadership in the face

of growing competition while at the same time connecting wider parts of the economy to this engine of growth. The authority will have the professional capabilities and maximum flexibility to allow it to take initiatives and efficiently promote technological innovation in industry at a pace that befits the market. The additional goals of the authority are encouraging growth, increasing productivity and promoting technological innovation in various fields of industry in Israel.

Chart 1. The Israeli R&D Innovation System



1.2.3 Research performers

Outside of government, most academic research is carried out in eight research universities. Private Research Organizations (PRO) do not play a central role except in the field of agriculture. R&D in the business sector is divided between local firms (many of which went public on NASDAQ), subsidiaries of multinationals (mainly American corporations), and a large number of technological start-up companies. Many of the local subsidiaries of multinationals were set up after the acquisition of local start-ups. One of the problems of Israel's relatively large venture capital industry is that it has become far more difficult to float Israeli companies on NASDAQ, the preferred option in terms of liquidity and visibility, meaning that most of the prevalent strategy for Israeli start-ups is through Mergers and Acquisitions (M&A)

In terms of specialization, there are two main fields of expertise, one which has been translated into a noted commercial success and another which has only partially delivered on expectations. There is a broad range of distinct successful ICT clusters in Israel with expertise ranging from semiconductors though communications to data security and various kinds of software. Academically, life sciences are another strong suit but this has been translated into a notable success only in the field of medical devices. Persistent government efforts to stimulate commercial success in pharmaceutical biotechnology have won only partial success (excluding Teva Pharmaceutical Industries –

an extraordinarily large international firm based in Israel). Another major area of expertise in knowledge intensive industries is defence exports, about which most information is classified.

2. Recent Developments in Research and Innovation Policy and systems

The situation is complex for the high-tech industry in Israel. On the one hand, 2014 was a record year for the success of start ups and for fund raising, and on the other hand, this year has seen declining indices in the manufacturing sector. Monitoring these trends and distinguishing between the characteristics and needs of start-ups versus large and medium-sized companies is essential to innovation policy in Israel, and is seen as the best way to move the country towards a more mature and integrated industry (OCS, 2015)[2].

The year 2014 was in many ways an excellent one for Israel's high-tech sector. About 700 Israeli companies raised € 2.56 bn. that year. This is by far the highest annual amount ever invested in the Israeli high-tech industry. Even venture capital funds have experienced a recovery in Israeli and raised more than € 678 m. Moreover, in 2014 there were about a hundred exits with a total value of € 5,27 bn. The number of IPOs this year was the highest in the last six years and was headed by Mobileye's issuance of € 768 m. This issuance, together with the sale of Viber for € 678 m., accounted for more than a quarter of the total value of exits during the period.

On the other hand, when considering the long-term trends of development of the product and employed in the Israeli high-tech industry, it is clear that the rapid growth that has characterized the industry in the past has come to a stop: in the period of activity prior to the crisis, 2004-2007, the sector recorded an annual average growth rate of 13.2% of GDP; during the crisis and after, 2007-2011, the average growth rate dropped to 4%. Employment reflects a worrying downward trend: in 2013, the total number of employees in the high-tech sector was 8.9% of all employees, compared to 2008, for example, where the rate of high-tech employees was 10.7%. The complete picture is of overall sluggishness in exports and stock market data. In three years of high-tech exports, as measured by exports of high-tech industry, the figures have hardly grown. In 2014, there was even a certain decline in the exports industry (excluding R&D service sectors) and the share of total manufacturing exports fell from 43.7% in 2013 to 42.7% in 2014.

According to the OCS, the Israeli high-tech sector is characterized by two distinct groups, differentiated in size and operating system. One is a mature industry of medium and large companies, whose activities in the high tech sectors affect the weight of aggregated data such as GDP, exports and employment. This industry is based on real activity and presents a relatively static behavior over time. On the other hand, there is an industry of fast operating firms – from companies to start-ups, much more agile and competitive, they are the ones operating in the area of venture capital and exits. This second group is responsible for the titles and headlines attributing to Israel the title "Start Up Nation", but at the same time this group is much more sensitive to waves in the stormy waters of the financial world.

These two groups constitute the business environment and are interrelated. Therefore, the Office of the Chief Scientist, the government body responsible for addressing the innovation policy in Israel, offers a varied portfolio of measures to boost innovation in Israel.

2.1 National R&I strategy

One remarkable issue in the Israeli innovation system is the lack of a clear national strategy (Trajtenberg, 2000). The society and the business sector are very much oriented by themselves towards innovation. In the general understanding of Israeli society, compared to most European ones, technology is seen as essential to the

[2] This section is based on the analysis conducted for the report (OCS, 2015) a collaboration between Evyatar Kirshberg, from the Central Bureau of Statistics and the OCS.

existence of the country. There is a tendency towards innovation and entrepreneurship (see section 5.2). The government follows an innovation policy of supporting some specific needs in some areas; however, it has understood that more flexibility is needed, in order to successfully help firms.

Thus the OCS has led the recent comprehensive strategic process that examined how to adapt to the dynamic reality. This process was adopted and approved by the Israeli government by government decision number 2092 to establish the Israel Innovation Authority, , and aims to further boost research and development activities and foster technological innovation in the economy. The new organization is the result of closer collaboration between the Ministry of Finance and the Ministry of Economics, and it aims to offer a more flexible environment towards its customers. Thus future potential innovators will be organized in the following domains:

1. Early Stage. Supporting innovators since the generation of the innovation aim at grouping previous existing programs: Incubators, Seed program, and Nuka.
2. Groups. Helping small and medium sized enterprise (SMEs) and big companies on their different projects. Basically will coordinate the previous R&D fund, a basic pillar in the public funding of innovation for Israel.
3. Academic and industry relations. Based on MAGNET, will focus on building and sustaining a healthy network of collaboration between the universities and firms. Closing the gap between the new knowledge successfully carried out by researchers in public and academics labs and the needs of innovative firms close on their activities to basic research.
4. Advanced manufacturing. Building on the traditional industries program, the plan is to support process innovation in traditional products by pushing firms to be at the peak of the innovation international frontier, and helping them to drive up the country's economy and diversify its exports.
5. Public and societal needs. This domain aims at serving societal goals. It will cover an extended spectrum of activities from the transmission of military technology to societal goals, oil substitutes and cyber security.

All these domains will have a horizontal provider of international services, to assist innovators in accessing the international markets, providing them with legal support and informing them of international funding from which they could benefit.

2.2 R&I policy initiatives

The list of R&D incentives in Israel was published by the Ministry of Economy and Trade in 2013. The document introduce the new initiatives (OCS, 2013):

Development of Technological Solutions for People with Special Needs

This new provision of the OCS was designed to encourage the development of technological solutions for people with special needs, which it defines as "physical, psychological, mental or cognitive disability – temporary or permanent – resulting in a fundamental disruption of essential daily functions." A special committee reviews the applications of non-profit and for-profit organizations with projects that do not meet other OCS support program criteria but do correspond to these goals.

The ETGAR Program - Grand Challenges Israel (GCI)

The OCS launched Grand Challenges Israel (GCI) upon joining the international initiative called Grand Challenges in Global Health. GCI will support the development of technological solutions relevant to world health and with an emphasis on R&D, which address humanitarian health problems in developing countries.

Some of the health and medical challenges facing developing nations are in the areas of

immunization, availability of health services, sanitation, parasitic diseases, pre-natal and post-natal care, mental health, medical equipment, etc. In addition, there are related areas such as food quality, waste water treatment, advanced agriculture, desert irrigation, ecology, etc. In many cases, these developments which provide help to developing countries also have great commercial potential in the world market.

National Program for the Return of Israeli Academics

The program is a cooperative effort involving the Council for Higher Education, the Ministry of Absorption and the Ministry of Economy and Trade. The objective of the program is, on the one hand, to support and encourage the return of developers and researchers to Israel, and on the other, to assist Israeli industry to absorb quality personnel. The program operates primarily in the establishment of relationships between returning Israeli scientists and researchers and the appropriate industry and/or academic institution. The program is managed by a steering committee headed by the Office of Chief Scientist and composed of representatives of the participating institutions along with representatives of the Ministry of Finance.

KIDMA programme

As the Internet plays an increasingly significant role in every aspect of life, cyber threats are rapidly becoming more complex and challenging, and their global influence is increasing. This raises the threshold for successfully developing adequate protection systems. Israel's unique advantages and leading global position in the fields of information security, computer security and communications security, make it a prominent player in the field of cyber defense.

In order to maintain and enhance Israel's abilities is this sector, the government issued Decision 3611 in mid-2011, calling for "The Advancement of National Capabilities in the Field of Cyber Security". Following this Decision, a programme has been devised by the OCS and the Israeli National Cyber Bureau (INCB), jointly allocating €15.5 m. to promote the development of advanced cyber defense solutions and establish cyber security knowledge centres. The programme will be executed through existing OCS Programs (R&D fund track and the Incubator programme).

R&D in Space Technologies

Israel has knowledge and development capabilities in many areas in the field of space technology. Due to the technological complexity of the space environment, the development of systems and assemblies which could function in space involves high technological risk, as well as high development and production costs.

In order to respond to these unique market conditions, the Ministry of Science and Technology and the Office of Chief Scientist (OCS) in the Ministry of Economy and Trade have jointly initiated a dedicated programme encouraging research and development in various space technologies.

Companies eligible for this provision include those developing: products to be installed in satellites or in earth stations, products designated for the reception or transmission of data from satellites, instruments designed for testing and calibration, and equipment to be installed in satellites or relating to their operation, including adjustment of satellite versions for export. An approved project may receive government funding for up to 36 months, subject to compliance with pre-determined milestones and in accordance with the approved business plan. Overall government funding per project must not exceed €4 m.

Alternative Fuels for Transportation

In 2011, the Government of Israel issued a resolution to carry out a national programme encouraging the development of technologies to reduce global consumption of petroleum-based fuels and boost the development of knowledge-based industries in the field of alternative fuels for transportation. The government resolution entailed the creation of an investment encouragement programme in this field.

The objective of this new programme is to encourage investments in Israeli companies specializing in the development and implementation of technologies in the field of alternative fuels for transportation. The government has designated an overall budget of €78 m. to be utilized by 2020.

Reduction of greenhouse emissions

In 2010, the Government of Israel launched a national programme for the reduction of greenhouse gas emissions. Through this programme, the government aims to reduce Israel's greenhouse gas emissions by 20%, compared to a "business as usual" scenario, within ten years. To do so, an investment support mechanism has been established to encourage the installation of cleaner and less polluting systems, by offering a subsidy of up to 20% of the cost of the project, up to a ceiling of € 1.3 m. In 2013 this project was effectively closed down.

In September 2015, Israel determined its INDC (Intended Nationally Determined Contributions) for the reduction of per capita emissions. It committed itself to reducing the per capita emission by 26%, compared to the levels in 2005, and announced a new National GHG Reduction Plan, which set the following targets:

- 17% decrease in electricity consumption (compared with business as usual based on 2015 trends)
- Increase in the use of renewable energy to 17% for total energy production. Currently 2% of electricity is produced from renewables
- 20% reduction in the use of private vehicles, compared to business as usual, through improvement of public transportation and a transition from diesel to compressed natural gas for heavy vehicles

The programme has been allocated € 105.03 m. In addition, € 63.22 m. will be provided in financial support from 2016-2019 to Israeli companies to invest in energy efficiency.

Designated Biotechnological Incubators

Biotechnological incubators support the formation of biotechnology startup companies in order to lead them toward clinical trials and Round A investments. For a period of three years, the program provides companies whose projects were approved by the Incubators Committee with full financial support (€ 1.5 m.) of which 85% is granted by the government and 15% is invested by the incubator), payable only upon generation of sales, in the form of 3% of the revenues annually.

Technology-Based Industrial Incubators

Technology-based industrial incubators support the ongoing operations of startup companies in order to lead them toward commercialization and market penetration. For a period of two to three years, the program provides companies whose projects were approved by the Incubators Committee with full financial support (€ 770,000) of which 50% is granted by the government and 50 percent is invested by the incubator), payable only upon generation of sales, in the form of 3% of the revenues annually.

Assistance for New Start-Up Companies

Seed companies typically find it difficult to raise the funds required in order to complete their initial R&D and become commercial. The financial crisis of recent years has created a leaner and more conservative global VC community. It has also increased the shortage of funding at this crucial stage of a company's life, known as "the valley of death". The State of Israel, through the OCS in the Ministry of Economy and Trade, has created a new program to address this issue.

This new program offers an approved seed company a funding commitment of 50% of the R&D expenses from the OCS, up to € 950,000 for up to two years. It then allows six months for the company to seek investors, thus giving the investor the assurance that (a) the rest of the funds necessary for the completion of the product development have

been obtained, and (b) the company in which the investor is considering investing is highly innovative.

Academitech – Student Initiative Competition

Academitech is a competition at the student level, established by the OCS for the development of an innovative product. The competitors are groups of students from institutions recognized by the Council for Higher Education who will present a Proof of Concept for a commercial product. Any field of study is eligible for the competition. The awards for the winners will be € 21,073 for the first prize, € 15,804 for the second and € 10,536 for the third, to be used toward the development and commercialization of the initiative.

The primary objective of the competition is to expose students to the world of entrepreneurship by providing support and direction to further their concept. The judgment criteria in this competition will be based on the idea of the product, the need that it addresses, the targeted market etc. The product should be innovative and unique and utilize either new or novel technology. The competitors will not be required to actually produce the final product but rather the idea should be relatively easy to implement.

Young Entrepreneurs

In order to keep Israel at the forefront of high-tech activity in the future, the OCS has embarked upon a program of encouragement and training of young entrepreneurs by involving them in various phases of development projects.

The program, in conjunction with Technological Incubators, provides high school students with the basic knowledge and foundation needed for their future as developers and entrepreneurs. The students enjoy all the services provided by the incubators from leading consultants and project leaders in various fields.

Thus the program provides high school students with knowledge and experience of the evolutionary process of a new technological development.

Israeli National Renewable Energy Center

The Government of Israel, in an effort to enhance Israel's capabilities in the field of Renewable Energy Technologies, has declared the creation of a technological center for renewable energy solutions in the South of Israel. The center operates a Venture Track, a Test and Validation Track and a Research Track. Through these tracks it supports technological entrepreneurship from the initial R&D stages to the production and marketing ones, as well as encouraging cooperation between academia and industry towards the development of innovative renewable energy solutions. The center also serves as a focal point for applied research in these fields. The State of Israel has allocated a budget for this program of € 10.5 m. over a five-year period. The Center was launched in 2012 by the investment firm Capital Nature, which had been selected to operate it after winning a government competitive process.

TELEM Forum

TELEM is a voluntary partnership between the OCS and the Ministry of Economy and Trade, the Ministry of Science & Technology, the Planning and Budgeting Committee of the Council for Higher Education., the Ministry of Defense and the Ministry of Finance. TELEM encompasses several programs aimed at establishing a national infrastructure for R&D in areas that are of common interest to the forum's members. The financing of the projects is carried out with TELEM members' own resources.

Support for Israeli Research Institutions

This program assists research institutions with clear links to industry in strengthening their technology infrastructure and developing relevant technologies and products. For a research institute to qualify for support, it must be an independent legal entity, employ a team of researchers with proven scientific and technological abilities, have equipment for

conducting and testing industrial R&D and gain at least 30% of its revenue by providing services to industry. Grants given may be up to 90% of the approved budget for up to two years. At least 10% of the budget of an approved project must be provided by an industrial company.

Long-Term R&D Support for Large Companies with Substantial R&D Investment

This program is designed to encourage long-term R&D – which is typically higher risk and more expensive – in companies with more than 200 R&D employees or an annual R&D budget of at least € 15.8 mand yearly revenues exceeding € 75.4 m. Grants may be up to 50% of the approved R&D budget. No royalty payments are mandated.

MAGNET

MAGNET (the acronym in Hebrew for Generic Pre-Competitive R&D) encourages collaboration among industrial companies, and between the companies and researchers from academic institutions, through several instruments that deal with innovative technologies. These instruments seek to develop Israel's industrial infrastructure by supporting the R&D activities and sharing technological knowledge among the participants. MAGNET works through the formation of consortia composed of industrial companies and academic institutions, in order to jointly develop generic, pre-competitive technologies. The duration of a MAGNET consortium is 3-5 years. Grants are up to 66% of the approved budget for industry and up to 80% for academic institutions.

NOFAR

NOFAR is designed to bridge the gap between know-how within academia and the needs of industry. It does so by encouraging support for applied academic research activity by an industrial company. The academic research group gains a better understanding of the market's needs and tendencies, while the company taps into ground-breaking discoveries in its field of activity. The program supports applied academic research in the following technological areas: biotechnology, nanotechnology, medical devices and storage of water and energy.

The project's budget is up to € 97,000 for a period of 15 months. Grants cover up to 90% of the approved budget, to be complemented by the industrial company associated with the project. No royalty payments are mandated. International technology companies are invited to connect with an Israeli academic research institute and take part in the programme.

Nanotechnology

From 2005 to 2012, six nanotechnology academic research centres were founded and put into operation in Israel. They were funded by collaborative private and public resources and collectively received a total budget of € 75,500 m.

A follow-up programme was implemented in 2012, for the next four years, the main goal of which is to establish a strong nanotechnology industry by transferring technologies from academia to industry and by creating a pool of skilled PhD and MSc graduates in Nano-science.

Isragrid

The goal of this programme is to enable efficient e-Science research in various fields by providing production e-Infrastructure that takes advantage of grid and cloud computing technologies. Isragrid offers the industry access to compute/data resources via EGI (European Grid Infrastructure), as well as user support and training.

2.2.1 Evaluations, consultations and foresight exercises

The work plan of the Office of Chief Scientist for 2015 includes innovation areas, organizational changes, expanding database tools, continuous assistance and listening to customer needs, and identifying trends and challenges in Israel. An analysis of the challenges already met by the Office has concluded that the main one now is to

strengthen Israel's lead cutting-edge success in the high tech industry. This major challenge will detail a number of evaluations, identifying the main points to be tackled in the coming years (OCS, 2015, Chapter 2), as follows:

1. The need to create new funding sources for industry: Although 2014 was a record year in raising funds for high-tech, a long-term review of the trend shows that the sources of funding suffer fragility: the model venture capital has experienced in recent years shook deriving from economic crisis. Moreover, the status of the local stock market has been eroded and many companies are choosing to raise money on foreign stock exchanges. In light of these changes, industry is required to obtain alternative sources of financing such as financial institutions or the general public through the mass finance platforms.
2. The challenge of helping start ups to become large companies: Israel is blessed with an abundance of start-ups, but many of them are quickly sold to big companies and they do not grow to produce in Israel. Large companies employ a large differentiated number of workers. The challenge of growing includes not only the generation of technology; but also the identification of market trends, an understanding of foreign cultures and familiarity with different business models.

3. The need to integrate technologies in traditional and public sectors: Israel's traditional industries are characterized by a low innovation intensity and productivity. Increased awareness of the need to renew, and expanding access to advanced technologies and R&D are the foundation for improving productivity in these areas.

4. Identification of systemic challenges in innovation: The complex system of innovation that operates in the high-tech industry can point to necessities that have implications for the industry but are difficult to point out. Nevertheless, the role of the Chief Scientist is to serve as an active player in identifying and voting on these challenges and to act as a catalyst for the development of a solution to them. For example, the worrying trends in terms of the need for highly qualified personnel constitute a significant barrier to the development of high-tech industry. Hence the OCS's commitment to point out the challenge, to become a partner in dealing with systemic activity and develop appropriate tools.

2.3 National and Regional Research and Innovation Strategies in Smart Specialization

The decision of the Israeli Cabinet to increase the Ministry of Science and Technology's budget for its regional research and development centres can be interpreted as a measure for Smart Specialization. The budget was increased by €1.8 million, a tripling of the budget, for the eight centres located in peripheral areas[3] in the north to the Negev desert in the south. The Ministry is a partner in the establishment of these centres, in guiding its scientific activity and contributing substantially in their funding.

The Regional Research and Development Centers were established in the peripheral areas to draw young, leading scientists into these areas, to contribute to the improvement of local society and to raise the level of local education. Furthermore, the Centers' research focuses on local challenges, conditions and resources in order to provide solutions for local needs. They thus present a ground-breaking model that is unique to the State of Israel.

An example of regional smart specialization is the area of Beersheva in the south of Israel, where the focus is on cybersecurity. The CyberSpark Industry Initiative has become the central coordinating body for joint cyber industry activities with government agencies, the Israeli Defense Forces (IDF), the public and academia. The Initiative is formulating a multi-year business plan, leveraging the region's significant strengths and maximizing its potential in the field of cyber security technology. It is marketing the

[3] The smart specialization programme of Galilee was analyzed by the Jerusalem Institute for Jewish Studies in 2012.

region and the city of Beer-Sheva as a global cyber security center, encouraging joint academia-industry partnerships and supporting the articulation of plans to recruit and develop human resources in the field, as well as incentive plans to attract other companies, whether international or Israeli, to establish projects or base themselves in the region.
Two new programs have already been launched: the Cyber Executive Academy CyberSpark, Israel – an International School of Cyber Training for Senior Executives and Decision Makers – and a CyberSpark Affiliates program. Accessing the cumulative knowledge of the CyberSpark partners, these professional programs offer participating companies and organizations access to the people and ideas that are shaping cyber security strategies and technologies today. Unfortunately, there is no monitoring strategy in place to track the evolution of these programs, as their evaluation is done internally by the Ministry responsible for them, and it has never been made public.

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2.4 Main policy changes in the last five years

The summary table below shows the timeline of the recent policy changes:

Main changes in 2011
… VATAT program. (Implemented in 2011 signed in 2010). A six-year program to improve and renew academic research.
…I Core Programmes for centres of research excellence. (First phase)
Main changes in 2012
… Kamin.
… Tzatam.
… Maimaid.
…II Core Programmes for centres of research excellence. (Second phase)
Main changes in 2013
…Kidma.
…R&D in space technologies.
…Alternative fuels for transportation.
Main Changes in 2014
…Solutions for people with special needs.
…Israeli National Renewable Energy Center.
…Program of assistance for seed companies.
Main changes in 2015
… Creation of the Israel Innovation Authority as a more flexible government institution.
…Telem forum.
… Cyberpark in Beersheva.

3. Public and private funding of R&I and expenditure

3.1 Introduction

Table 2 Basic indicators for R&D investments

Indicator	2011	2012	2013	2014	EU average (last available year)
GERD (as % of GDP)	4.01 %	4.13 %	4.09 %	4.11 %	2.03 % (2014)
GERD (Euro per capita)	1,025	1,124	1,146	1,119	536 (2013)
GBAORD (€m)	1,130	1,184	1,238	1,457	
R&D funded by BES (% of GDP)	1.55 %	1.42 %			1.12 % (2013)
R&D funded by PNP (% of GDP)	0.45 %	0.48 %			0.03 % (2012)
R&D funded by ONS[4] (% of GDP)	0.15 %	0.14 %			0.05 % (2012)[5]
R&D funded from abroad (% of GDP)	1.88 %	1.95 %			0.19% (2012)
R&D performed by HEIs (% of GERD)	12.92 %	12.80%	12.55%	12.31%	23.38 % (2013)
R&D performed by government sector (% of GERD)	2.09 %	1.99 %	1.89 %	1.89 %	12.43% (2013)
R&D performed by business sector (% of GERD)	83.79 %	84.11 %	84.46 %	84.71 %	63.68 % (2013)

In terms of public investments in R&D, Israel seems to be recovering from the effect of the crisis as can be seen in the table above. GERD, measured as a percentage of GDP, rose steadily from 4.01% in 2011 to 4.11% in 2014. This highlights the recovery of the research and innovation system to global financial conditions, and stems from the very high share of business in funding R&D. Total GERD figures relate only to civilian R&D, as there are no unclassified data on the total expenditure of the large defense related R&D system. The government has never set out specific targets for R&D expenditure, and is unlikely to do so in the future.

The contribution of the business sector to the funding of R&D continues to rise, with its share of GERD reaching 84.71% in 2014. These levels, although normal for Israel, are surprisingly high, especially when compared with the EU average for 2013, where BERD contributed 63.68% of the GERD.

According to last available data[6], in 2014 national expenditure on civilian R&D was 4.11%, following a constantly increasing trend from the level of 4.01% in 2011 (See Table 2). Following these estimations by the CBS, in 2014 the national expenditure on civilian R&D, at constant prices, increased by 3.4%, following an increase of 0.4% in 2013 and of 4.1% in 2012.

The expenditure on civilian R&D (at current prices) in the business sector amounted to € 7.66 bn. in 2014, comprising 84.71% of total national expenditure on R&D. The rest was expenditure on R&D carried out at universities (12.31%), in the general government sector (1.89%) and in private non-profit institutions (1.09 %).

[4] ONS . Other National Sources. The author was not able to obtain information on HES. These data come from MSTI Table Eurostat. The average for the EU isalso taken from the MSTI database.

[6] Data provided through personal contact with the Israeli Central Bureau of Statistics (June 2016).

Taking a deeper look at the business sector, the development, at constant prices, reflects a 3.6% increase in expenditure on R&D in the business sector in 2014, following an increase of 0.1% in 2013, and of 4.5% in 2012. This sector includes computer programming, consultancy and related activities (software); scientific research and development (R&D); and manufacturing industries. In 2014, the expenditure on R&D in computer programming, consultancy and related activities (software) increased by 5.5%, at constant prices, following an increase of 4.4% in 2013. The expenditure on scientific research and development (R&D), including start-up companies, international R&D centres, technological incubators and research institutes, increased by 5.1%, after a decrease of 2.2% in 2013.

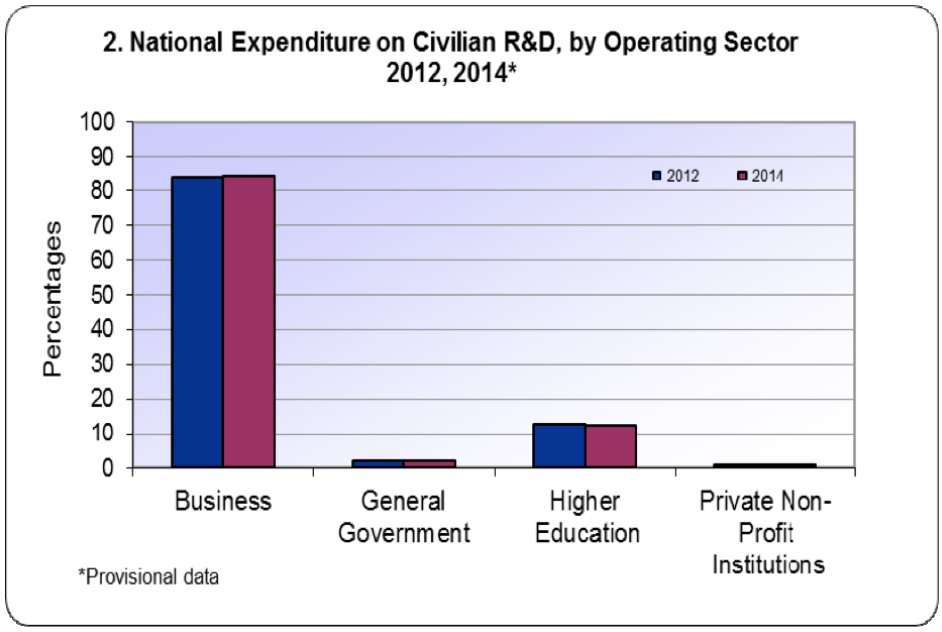

Figure 1. Evolution of R&D 2014, by Operating Sector (CBS data).

3.2 Smart fiscal consolidation

Israel is an example of a country that has followed the principle of smart fiscal consolidation. The principle of smart fiscal consolidation, albeit it is not a concept used in public discussion. Hence, government debt has fallen from 69.9 % of the GDP in 2012 to 67.5% in 2014. Moreover, it seems to follow a stable decreasing trend. Meanwhile the proportion of public expenditure in R&D rose in those same years from 3.97% to 4.21%. The public debt has been reduced, yet it has never been at the expense of public investment in innovation. The country is well aware of the role of technology in society, and the public spending on science and technology is normally reviewed for increase before the approval of the next public budget

3.3 Funding flows

3.3.1 Research funders

The main funders of public investments in Israel are the Ministry of Economy and the Ministry of Finance, while the Ministry of Education deals with the increase in the quality of researchers in Israel. These three main bodies represent the majority of public investment in the country (see section 1.2.3). The Ministry of Science and Technology, with a much smaller budget, as well as the Ministry of Finance, also carry out a number of innovation projects. In general, all the ministries deal with innovative ideas and proposals that are close to their corresponding political area.

Other important actors in the Israeli innovation system are:

- The Israel Science Foundation (ISF), which is Israel's predominant source of competitive grants for funding basic research. Its roughly € 105 m. million annual budget funds more than 1,500 grants a year, providing 2/3 of all such funds. Every year, more than 15,000 expert reviewers, some from Israel but most from abroad, are involved in peer-reviewing the scientific merit of the proposals submitted. The ISF awards grants to Israeli researchers at Israeli universities, other institutions of higher education, research and medical centers. Most funds (96%) are provided by the Government of Israel via the Planning and Budgeting Committee (PBC) of the Israel CHE.
- Bi National and International Funds. (see sections 4.2 and 4.3)
- The OCS deals with all the new funds introduced in recent years (see section 2.2)
- I-CORE - the Israeli Centers for Research Excellence - is an initiative designed by the Planning and Budgeting Committee and the Government of Israel, which is gradually establishing leading research centers that specialize in a range of disciplines. The Centers of Excellence and the program's vision are aimed at fundamentally strengthening the long term positioning of Israel's academic research and its stature among leading researchers in Israel and abroad.
- The University Research Authorities: Bar-Ilan University, Ben Gurion University, the Hebrew University, the Open University, the Technion, Haifa University and the Weizmann Institute.
- Foundations: each university is associated with a principal foundation that supports innovation.
- The University Vice-President or Deans for R&D.

3.3.2 Funding sources and funding flows

Israel has been steadily increasing its participation in the different Framework Programmes (FP). It has become especially important, since during the last negotiations dealing with the participation of Israel in the H2020, the tension between Israel and the European Commission raised to the media. Scientists and politicians in Israel highlighted the need for these collaborations to continue (see Garcia-Torres, 2013).

Table 3 shows that the participation of Israel in FP6 accounted for 17.25 % of all the contributions to associated member states. In addition, if we compare with the total contribution given to EU members it represents 1.1 % of the total grant given to the EU28. In the case of FP7, 21.21 % of the total provision was given to associated member states which represents a 2.11% of the total provision given to EU28 For H2020, given its early stage it may be too soon to derive conclusions but based on the number of projects already signed, Israel has reached 31.75 %. The evolution shows the clear involvement of Israel in the European research programs as well as increasing participation in them. However, the table should be compared with caution, since different Framework programs have run for more than a year, and this makes it difficult to compare these resources to national ones, which are mostly given yearly.

Table 3 Participation of Israel in FP and H2020

	No. of projects	% No. of projects	No. of participants	No. of coordinators	EU contribution €	% of total AMS EU contribution	% of total EU28 EU contribution
				FP6			
Israel	592		772	117	174,838,876	17.25%	1.11%
Total Grant to Associated MS	3.602	16.44%	5.080	570	1,013,504,931	100%	6.44%
Total Grand to EU28	36796	1.61%	67696	9328	15,749,796,104		100%
				FP7			
Israel	1.641		1.998	796	862,647,412	21.21%	2.11%
Total Grant to Associated MS	8.471	19.37%	11.100	2.656	4,067,287,591	100%	9.94%
Total Grand to EU28	72.440	2.27%	120.697	23.204	40,917,932,471		100%
				H2020			
Israel	390		533	242	308,247,000	31.75%	
Total Grant to Associated MS	1.101	21.89%	1.441	295	n.a.	100%	
Total Grant to EU28	13.219	1.82%	21.851	4.970	n.a.		100,00%

3.4 Public funding for public R&I

3.4.1 Project vs. institutional allocation of public funding

According to the data provided by the CBS in Israel[7], competitive funding was 37.8 % of the total institutional public funding in the 2011 budget. This represents a mild increase after 2010, though still without reaching the 2009 level of 39%. A large proportion of the competitive funding is awarded by the Israel Science Foundation (ISF), the main source of competitive grant funding for basic research in Israel. With an annual budget in 2014 of roughly €105 m., ISF funds more than 1,500 grants a year, providing 2/3 of all such funding in the country. Its funds are mostly (96%) provided by the Government of Israel via the Planning and Budgeting Committee (VATAT) of the Israel Council for Higher Education (CHE).

Funding for universities is expected to increase annually by 30% over the course of the VATAT plan, while allocations to the ISF will nearly double. In 2012, the total budget for Higher Education was € 8.2 bn. However, the proportions between block and competitive funding are unlikely to change to any significant degree because the share of total university funding earmarked for research, as opposed to teaching, is increasing from about 40% to 50%.

[7] Data provided through personal contact with the Israeli Central Bureau of Statistics (October 2015)

3.4.2 Institutional funding

Government ministries' expenditure on civilian R&D amounted to € 1.45 b. in 2014. The expenditure includes conducting research, commissioning research from other institutions and transfers for financing of R&D in other sectors, including the General University Fund. The Ministry of Economy and Trade, which constituted 62% of the overall expenditure of Government ministries on R&D, financed most of the government ministries' R&D (excluding GUF). The Ministry of Economy and Trade's R&D expenditure increased, at current prices, by 5.6% in 2014.

The breakdown of expenditure on civilian R&D for government ministries, by objectives, shows that in 2014 the share of grants for the advancement of research, which mainly includes the financing of the General University Fund and is oriented towards the universities, amounted to 56%. Expenditure for the advancement of industrial technology amounted to 30%. The main expenditure in this field was for grants awarded by the Ministry of Economy and Trade to industrial companies; 6% of R&D expenditure, in 2014, was allocated to R&D in agriculture; 3% for research in social services (education, labor, social welfare, immigrant absorption, etc.), and 3% was allocated to R&D in infrastructure (including research on transportation and on urban and rural planning).

To fund and coordinate research initiatives, there is a voluntary forum called TELEM, composed of the chief scientists of the Ministry of Economy and Trade, the president of the Israel Academy, and representatives of the Council for Higher Education, the Treasury, and others. There is no institutional evaluation of the programs.

The Israel Science Foundation (ISF) is the main body supporting breakthrough basic science in Israel, based on scientific excellence within the different fields of knowledge, in a wide variety of funding opportunities. The ISF focuses on the following main fields: exact sciences and technology, life sciences and medicine, humanities, social science and special programs.

The selection of the successful projects is conducted in the following way: in order to obtain a minimum of three to four reviews for each research proposal, the ISF contacts approximately ten potential reviewers, national or international, for each proposal. Despite the increase in the number of research proposals submitted each year, the ISF succeeds in keeping to an average of four reviews per proposal. A set of different professional committees is formed every year depending on the topics submitted, and it is in charge of distributing the budget. The selection criteria are based on the assessment by the professional committees. The success rate is 42.5% of the proposals submitted. Since 2002, 2.1% of the ISF total budget has been devoted to individual grants in the form of post-doctoral grants.

3.4.3 Project funding

3.4.4 Other allocation mechanisms

Although it is neither a project nor an institutional allocation of funding, it is worth highlighting the cluster called "Silicon Wadi". It is an area with a high concentration of high-tech industries on the coastal plain in Israel, similar to Silicon Valley. The area covers much of the country, although especially high concentrations of hi-tech industry can be found in the area around Tel Aviv including small clusters around the cities of Renana, Petah Tikva, Herzliya, Netanya, the academic city of Rehovot and its neighbour Rishon Le Zion. In addition, hi-tech clusters can be found in Haifa and Caesarea. More recently such clusters have been established in Jerusalem, and in towns such as Yokneam Illit.

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

The main public programs for public policy are organized around the idea that really successful innovations use the VC markets to obtain the support they need. A large proportion of R&D is performed in the business sector with a huge proportion of the investment coming from foreign investors. The public policy for innovation represents only a small slice of the big innovation pie, but the public sector is well aware that its role is only marginal and covers the needs that private markets are not able to supply.

In general, the OCS in collaboration with the Ministry of Finance has created the Israel Innovation Authority (see section 2.1) with the clear idea that more flexibility was needed to meet the special needs of innovators. In general, the OCS is aware of the need for financial support not only to SMEs but also to new ideas in its earliest stages, which is why it has a pre-seed program. The idea is to cover all the different needs of innovators, from the initial stage until the product is brought to the market. A special domain of the Isarel Innovation Authority is devoted to societal needs, to complement the ongoing research carried out in Israel (see section 3.4.3.6).

Collaboration between the public and private sector is stimulated basically by MAGNET, the consortia created to close the gap between academy and high tech industry. Some more specific programs included under this umbrella are NOFAR, Meimed, TELEM and Tzatam. (For a better description, see Section 2.1).

In general, very little research has been done on benchmarking innovation in Israel, apart from the international comparisons made by the international organizations OECD, IMF and European Commission. Programmes are evaluated internally by the Ministries, but such evaluations are not made public.

Public procurement in Israel relates mostly to the R&D Fund, which is the main instrument of the R&D Law. It gives grants to "Approved R&D Programs", which are programs lasting one or more years, and resulting in the development of a new product or in a significant improvement to an existing one. It may also lead to a new industrial process or, again, to a significant improvement in an existing one.

A special track is dedicated to traditional industries (those characterized by relatively low investment in R&D). This track offers separate evaluation and discussion for projects. Another special track, which has been operating since 2010, supports large companies in establishing their R&D centres on Israel's periphery. It aims to bridge the gap between Israel's centre and its periphery, by convincing large companies to locate their R&D centres in areas with less economic growth. This creates a mechanism of increased quality employment and economic activity within the target geographical areas.

There is no strategic framework of innovation procurement in Israel. There is an intention to offer public services online, but it is in the discussion phase, and there are no financial incentives to undertake innovation procurement.

3.5.2 Indirect financial support for private R&I

Income tax ordinance allows recognition of a company's R&D expenses incurred for promotion and development as suitable for tax deduction. This is on condition that these expenses are due to scientific research in the fields of industry, agriculture, transportation and energy and are approved by the OCS. These expenses will be deductible regularly during the tax year in which they were paid. If the scientific research expenditure is not approved by the OCS, the expenses will be deductible in three equal annual instalments starting in the fiscal year in which they were paid.

Israel's corporate tax rate is 26.5% of business income. The OCS of the Ministry of Economy implements the government's policy encouraging and supporting industrial research and development. They are responsible for promoting industrial R&D that is

likely to lead to new export products. The following incentives are available only if approved by the OSC after applying the following criteria: the proven technological skill of the applicant, a plan to implement the project in Israel (unless exempted by the research committee of the OCS), and the high standards of technological innovation are met.

Tax benefits are given to two kinds of companies: those located in priority area A (central area), which are eligible for a lower tax rate of 7% in 2013-2014 and 6% for years after 2014. Companies that are not located in priority area A are eligible for a lower tax rate of 12.5% in 2013-2014, and 12% from 2015 onwards. If the company pays dividends during a tax year in which the complete exemption is effective, the dividends are taxed at 15% and any exempted taxes become payable immediately. Companies located in Priority Area A may also qualify for grants for investing in their manufacturing facilities. Grants are distributed by the Investment Center at the rate of 20% out of the total investment. There are other special benefits for selected fields, like traditional industries and large corporations generating employment outside the industrial periphery.

3.6 Assessment

As mentioned in the previous section, the role of public R&D funding in Israel plays a minor role. However, there is a good mixture between project and institutional support measurements. Competitive funding is always implemented via peer review with renowned international professors on most of the committees.

The Israeli innovation policy aims at covering the failures that the free market is not able to cover. There is almost no indirect support that does follow a strategic project for innovation and most innovation policy is implemented through direct funds. Innovation policy is divided across too many ministries and a higher level of unification could benefit the country. Moreover, there is not a clear political position towards a direction among many possible different technological paths that the country could follow. The direction of the technology in Israel is decided by industry, and mostly based on profitability decisions, but so far the country has been extremely successful in most of its technological trajectories. The mixture between funding allocation has changed very little in the last years. However, this indicates that the country has recovered from the shocks of the international crisis at least in relation to investments in R&D.

4. Quality of science base and priorities of the European Research Area

4.1 Quality of the science base

Indicator	Year	EU average
Number of publications per thousand of population 2013	2.04 (FULL) 1.44 (FRAC)	1.43 (FULL) 1.22 (FRAC)
Share of international co-publications 2013	46.6%	36.4 %
Number of international publications per thousand of population 2013	7573	262593
Percentage of publications in the top 10% most cited publications 2010	14.44 (FULL) 11.6 (FRAC)	12.25 (FULL) 11.41 (FRAC)
Share of public-private co-publications 2011-2013	3.3% (Scival) N/A	1.8%

Israel is a highly knowledge-intensive country. It has a strong and dynamic academic sector and has achieved excellence in scientific and technical education and research. As commented in previous sections, Israel is well above the EU average for the majority of the R&I indicators. A similar comparison is made for indicators of the quality of the science: in 2013 the number of publications per thousand of the population was 2.04 while the average for the EU was 1.43. It is well ahead in the international index for co-publications, reaching 46.6% in 2013 compared to the average of 36.4% for the same year. The percentage of publications in the top 10% of journals in 2010 was 14.44 compared to 12.25 for the EU average. Indeed, Israel's overall level of innovation performance places it among the group of European "innovation leaders". The share of private public collaborations for 2011-2013 was twice as high as the EU average, a remarkable difference.

The increase in research via open national competition in Israel is channeled through two main sources, the competitive R&D fund and the VATAT. The competitive R&D fund is the main instrument of the R&D law. It gives grants to approved R&D programs that last one or more years, resulting in a new product or process. It is therefore a grant given to firms for applied research, and the development may lead to a new industrial process or to a significant improvement in the R&D. The Planning and Budgeting Committee (VATAT) is the main instrument for financing basic research, i.e. research done by universities. In Israel they remain autonomous: once they are given their budget they are at liberty to decide how to use this budget within the university – for teaching or for research. The financing is allocated by VATAT, following a model by which the universities´ achievements both in teaching and research are measured.

Israel has been associated with EU research and innovation programs since 1996. The collaboration between Israel and Europe can be explained through three main areas: H2020, the program EUREKA, and bilateral collaboration with European countries. During the last FP7 programme (2007-13), Israeli public and private institutions contributed their scientific expertise to over 1,500 projects. Reflecting the strength of Israeli research, Israeli participants achieved a high success rate, particularly in obtaining European Research Council (ERC) and Marie-Skodowska Curie grants. In the thematic programs, Israel participated most actively in the areas of Information and Communication Technologies (ICT), Health, demographic change and wellbeing and Nanotechnologies, Advanced materials and Advanced Manufacturing and Processing.

Overall, 8,984 Israeli entities were included in 6,109 submitted program proposals, resulting in 2,115 Israeli entities participating in 1,200 retained projects, with a total cost of €10.1 billion. The total grant value for Israeli entities amounted to €875.6 million. On its side, Israel contributed over € 530 million to the programme.

On June 8, 2014, Israel signed an agreement to join Horizon 2020, the eighth European Framework Program for R&D. Retroactively joining the program officially as of January 1, 2014, Israel has access to the €70 billion in total program funding of which Israel will contribute about € 1 bn. during 2014-2020. The central objective of Horizon 2020 is to maintain the European Community's status as a world leader in science and in industrial innovation through the availability of capital, along with support for SMEs (see Table 3 in subsection 3.3.2). Horizon 2020 provides funding in the following areas: health, food, agriculture, biotechnology, bioeconomy, information and communication technologies, big data, nano-sciences and nanotechnologies, energy, environment and climate change, transport and aeronautics, socio-economic sciences and the humanities, space and security. Horizon 2020 allows mobility of research, promotes pioneering research and enables Israeli entities to cooperate in technological development with European industries, research institutions and universities, and showcase Israeli technological abilities. Through Horizon 2020, small and medium-sized enterprises that are EU-based or established in a country associated with Horizon 2020 can obtain EU funding and support for innovative projects that will help the enterprises to grow and expand their activities into countries in Europe and elsewhere. From the begining of H2020 (2014), 3,631 Israeli participants were included in 2,616 submitted proposals resulting in 391 retained projects, with a total cost of 1.952,5M€ ..

Israel is an active participant in the EUREKA Network, Europe's leading platform for R&D entrepreneurs and industries. EUREKA is an inter-governmental public network of over 40 member countries and three associated countries. EUREKA supports R&D-based businesses and institutions through funding and partner-matching services. On a yearly basis, EUREKA supports more than 300 collaborative projects in a variety of industries, totaling over €1.2 billion. Projects can be launched in virtually all industry fields and technological areas — information and communications technology, manufacturing, water technologies, communications, biotechnology and energy. In July 2010, Israel took the reins of the EUREKA Network as its year-long chair. Leveraging Israeli best practices in technological innovation, the Israeli EUREKA chairmanship focused on promoting a culture of innovation and developing new sources of funding for start-up companies, small and medium sized enterprises and research institutions in Israel, throughout Europe and the world. Israel is among EUREKA's most active participants; of EUREKA's member and associated countries, Israeli companies have partnered in more than 10% of all EUREKA's projects.

Israel participates in the following active Era-Nets - The ERA-NET is instrument under R&D European programs .They designed to support public-public partnerships in their preparation, establishment of networking structures, design, implementation and coordination of joint activities as well as topping up of single joint calls and of actions of a transnational nature.Israel participated in ERA-NET'S under :

FP-7: ARIMNet2, ERA-IB-2, ENTIII, EURONANOMED II, FLAG-ERA INCOMERA, Infect-ERA, ICT- AGRO 2 ,MANUNET II,PathoGenoMics'etc…

Horizon 2020: JPco-fuND,M-era,M-eranet,ErasysBIO,TRANSCAN-2, WaterWorks2014,LEAR-ERA, ERA-NET Plus, NEURON-ERANET,ECO-Innovera,MED-SPRING, etc…

Israel is partner in several Joint Undertakings : Single European Sky Air Traffic Management Research (SESAR), Shift2Rail (S2R),Clean sky, Electronic Components and Systems for European Leadership (ECSEL) and others.

At a bilateral level, Israel implements a large number of R&D agreements with major European countries, including France, Germany, Italy, the Czech Republic, Finland, Greece, Hungary, Lithuania, Spain, Sweden, Turkey, Poland, Romania, the UK, Russia and others. Israel Innovation Authority - ISERD also implements collaborative programs with European regions, clusters and industries, including Rusnano - Russia, Cap Digital, Systematic and Medicin in France, ISS in Italy, CDTI and Accio in Spain and British Water in the UK.

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

This chairmanship additionally aided in developing new instruments to support innovation and industrial growth through R&D cooperation, in particular the EUREKA Cleantech Action and E!nnovest financial instruments. The other relevant collaboration is EUREKA, which incorporates 43 national funding schemes in virtually all European countries and the European Union. EUREKA facilitates approximately 400 projects every year, mobilizing € 1.5 bn. of public and private funds. Over 40 % of EUREKA project participants are SMEs, which are the prime target group for Eurostars – a EUREKA-EU joint program aimed at supporting R&D-performing SMEs (including start-ups) through improved support mechanisms. Eurostars announces two open calls every year for close-to-market projects led by SMEs in any industrial domain and funds approximately 150 projects each year.

Also among EUREKA's activities are the Industrial Cluster sub-programs, which are initiated and managed by large multinational corporations (MNCs) in selected areas. The majority of clusters are active in information and communications technology (ICT), and energy and water technologies. Initiating companies in this project include Philips, Siemens, Veolia, Alcatel, Thomson, Ericsson, Nokia, France Telecom, Telefonica, Deutsche Telekom and other market leaders

4.2.2 RI roadmaps and ESFRI

The Ministry of Science and Technology started to work in 2010, on RI roadmap for Israel. The research was conducted by the Samuel Neaman Institute- into the possible ways of working on an RI roadmap for Israel (Getz et al. 2010) and the potential benefits of following some of the examples of advanced countries. The purpose is to compile a database which would constitute the basis for a road map setting out the establishment of National Research Infrastructures in Israel. The follow-up research began in May 2012 with the aim of completing a more comprehensive mapping of existing research infrastructures in Israel. The study offers an updated mapping of these infrastructures and describes the methodology used. A total of 119 research infrastructures appear in it, of which 87 were previously mentioned in the 2010 report, and the remaining 32 are newly mentioned. The mapping shows that 58% of the infrastructures are located within academic institutes, 30% in public and governmental institutes and 12% within industry. To complete the picture of the research infrastructures available to researchers in Israel, the chapter includes information on ten international research facilities which are used by Israeli researchers and funded by government budgets. It also examines research infrastructures at the national level in relation to three main fields: nanotechnology and nanoscience, brain research, and genomics and proteomics. This allows for an assessment of the current availability of research infrastructures to researchers in these fields.

VATAT decided to initiate a process of medium and long term strategical planning, to enable it to proactively,(and based on its set of priorities), develop and establish central academic research infrastructures, and to join existing international research infrastructures. Accordingly, in 2012 the assembly of the PBC decided to establish a permanent advisory committee (under the PBC) to deal with the issue of central

academic research infrastructures. The roles of the Committee were to create prioritized RI roadmap

Following this research, VATAT created the "2013 Roadmap for Central Academic Research and Infrastructure in Israel", in order to develop a more precise strategy for RI. In principle, new information concerning the Roadmap of Israel is expected to be published in the near future.

Israel is already a member of an ESFRI projects such as GEANT, PRACE, INSTRUCT, EMBRC, ELIXIR, SHARE and ESSurvey-1. The country is interested in maintaining its membership in the above RIs and in joining others such as other ERICs and ESO.

4.3 International cooperation with third countries

In this framework, two nations contribute a predetermined sum to a binational foundation intended to support cooperative projects. A board of directors is appointed by the two governments, and each fund establishes its own criteria and procedures. A designated non-profit organization manages the funds and administers grant payments. In addition to providing R&D projects with financial support, foundations search for business partners in both countries for the purpose of collaboration in technology development projects. Binational foundations do not receive equity or intellectual property rights in the companies supported, nor do they interfere in formulating or managing relationships between partnering companies

US-Israel Binational Industrial R&D Foundation (BIRD)

BIRD is a key catalyst for joint R&D between American and Israeli companies, focusing on emerging industries and novel technologies. Any pair of companies, one Israeli and one American, may jointly apply for BIRD support provided they have the combined capability and infrastructure to define, develop, manufacture, market, sell and support an innovative product based on industrial R&D. One of the two companies is typically involved in the development of cutting edge technologies while the other offers large-scale product development and commercialization. The BIRD Foundation provides conditional grants for joint development projects on a risk-sharing basis. The Foundation funds up to 50% of each company's R&D expenses associated with the joint project and repayments are due only if commercial revenues are generated as a direct result of the project. If a project fails, BIRD claims no repayments. Moreover, it requires no equity in the companies supported and no intellectual property rights, nor does it interfere in formulating or managing the relationship between the partnering companies.

BIRD's scope extends to communications, life sciences, electronics, software, cleantech and other technology sectors. Since its inception in 1977, BIRD has approved over 800 projects, and cumulative sales of products developed through its projects amount to approximately € 7.35 bn.

Canada-Israel Industrial R&D Foundation (CIIRDF)

The Canada-Israel Industrial R&D Foundation (CIIRDF) was established in 1994 to promote and support collaborative R&D between firms in Canada and Israel. CIIRDF offers grants for joint projects and searches for suitable partners in Canada and Israel to collaborate in technology development projects. Additionally, it is entrusted with the implementation of the Ontario agreement, focusing on projects connected with brain research and water technologies. CIIRDF's support includes funding of both feasibility studies and full projects. Support can reach a maximum of 50% of the approved R&D costs of joint projects, up to a ceiling of € 603,200. CIIRDF requires no equity in the companies it supports and no intellectual property rights in their products. It requires only that the nominal grant is repaid – interest free – on the basis of royalties if commercial revenues are generated as a direct result of the project.

Korea-Israel Industrial R&D Foundation

The Korea-Israel Industrial R&D Foundation (KORIL-RDF) was established by the Korean and Israeli governments in 2001 in order to promote and support industrial R&D joint ventures between companies in Israel and South Korea. Funding can be obtained for up to 50% of the joint R&D costs of a project, to a maximum of € 754,000. At least 30% of the R&D development must be performed in either Korea or Israel. KORIL-RDF assists companies in both countries with partner searches in order to develop R&D collaborations. The foundation's main office is in Seoul, Korea; an Israeli manager is based in Tel Aviv.

Singapore-Israel Industrial R&D Foundation (SIIRD)

The Singapore-Israel Industrial R&D Foundation (SIIRD) is a cooperative venture between the Singapore Economic Development Board (EDB) and the OCS in Israel to promote, facilitate and support joint industrial research and development projects between companies from Singapore and Israel. SIIRD assists in locating suitable R&D partners in both countries and shares in project risk. The Foundation may fund up to 50% of approved costs of joint R&D projects. Total grants for the project may reach a ceiling of € 754,000 but may not exceed € 377,000 for any one year. SIIRD does not require equity or collateral and companies retain full intellectual property rights. SIIRD has to date approved approximately 112 joint projects with a total budget of over € 120.64 m.

US-Israel Science & Technology Commission and Foundation

The US-Israel Science & Technology Commission (USISTC) provides a unique and highly beneficial environment for the promotion of binational cooperation at the highest levels of government and industry. Together with its implementation arm, the US-Israel Science and Technology Foundation (USISTF), the Commission focuses on developing areas of binational strategic importance, such as life sciences, space research and renewable energy. The Commission acts as a catalyst by identifying and removing impediments, as well as building a binational infrastructure for mutually beneficial economic and technological cooperation.

BIRAX Regenerative Medicine Initiative

BIRAX (the Britain-Israel Research and Academic Exchange Partnership) is a € 12.5 m. initiative of the British Council and the British Embassy in Israel in collaboration with the Pears Foundation and the UJIA. BIRAX funds cutting-edge research using stem cell and regenerative medicine therapies to tackle some of the world's most challenging conditions and diseases including cardiovascular and liver disease, diabetes and Parkinson's. Over € 8.75 m. has been committed to 15 world-class projects including eight joint medical research projects announced in February 2015. These included research to use heart cells to restore damaged heart muscle and the use of breath tests for the diagnosis of Parkinson's Disease.

4.4 An open labour market for researchers

4.4.1 Introduction

Total national expenditure on education in 2013 amounted to € 17.43 bn., 8.0% of the GDP. In 2013, the national expenditure on education (at constant prices) increased by 6.8%, following an increase of 4.0% in the previous year, and 2.0% in 2011. In 2009 (the last year for which data are available), there were some 54,400 researchers in Israel: 83% in the business sector and the remainder in the academic one. This breakdown matches the breakdown of R&D financing in Israel, with some 80% coming from the business sector.

After increasing by 18.5% between 2005 and 2007 (the increase was entirely in the private sector), the number of researchers did not increase at all between 2007 and 2009. This was apparently the result of the global recession, which also reduced the volume of business sector innovation financing. The fact that the number of researchers in the academic sector remained unchanged until 2009 – together with the relatively low

share of researchers in this sector – clearly indicates a supply problem regarding researchers at Israel's universities.

In 2014, Israel continued to lay emphasis on its main challenge in the area of flows of researchers, particularly in the academic sector: to attract researchers – both Israelis working abroad and foreign researchers – to do their research in Israel. The policy vehicle implemented to meet this challenge was the establishment of Excellence Centres (known by the generic name I-CORE – Israeli Centres of Research Excellence) as part of a new six-year plan which will offer significantly increased budgets for higher education, both for teaching and research: the plan, including the I-CORE initiative, was presented to the Government of Israel in March 2010 and its implementation continued during 2012. The total six-year budget for the establishment of the 20 Centres is some € 320 million out of a total budget for the plan of € 1,280 million.

The main goals of I-CORE are to reinforce excellence in Israeli universities, improve their competitive position globally and reverse the brain drain by attracting back to Israel senior researchers who have worked abroad for an extended period. Together with the I-CORE, the country has implemented the Israel National Brain Gain Programme with the intention of attracting back highly qualified workers (see section 6.1).

4.4.2 Open, transparent and merit-based recruitment of researchers

The profile of Israel mostly fits into an institutional type of staffing autonomy, where universities have freedom to decide on how to select their candidates. However, in general it is a transparent recruitment procedure. The rules are known, and in most cases the members of the selection panel are publicly known and they normally consist of national and international experts in the pertinent field.

The Ministry of Education has a special process for recognizing and validating foreign qualifications which is very important in Israel, given the huge number of immigrants entering the country every year. The high level of researchers' qualifications make then suitable in any international market. In general, in Israel the outflow of researchers is greater than the inflow, and as mentioned in section (2.2.1) there is a need for highly qualified professionals both in industry and in academia.

Given its high potential for new technologies and its vibrant academic environment, the country is very attractive to foreign researchers. Potential barriers are of course the language – although most research is carried out in English – and probably the instability related to the Middle East conflict in the area.

4.4.3 Access to and portability of grants

Grants in Israel are portable within the national territory but not abroad.

4.4.4 Doctoral training

Israel boasts 8 universities, 33 academic institutes, 23 academic colleges, and 4 academic programs in colleges under the auspices of universities. Academic and teacher-training colleges award Bachelor's and Master's Degrees (generally a non-research provision. Only universities may award all three degrees: Bachelor's, Master's and Doctorate. Universities are completely independent in the organization of the doctoral programs.

The Council for Higher Education (CHE), established in accordance with the Council for Higher Education Law, 5718-1958, is the regulatory body responsible for the academic aspects of all institutions of higher education in Israel. The establishment of higher education institutions must be done with the authorization of the CHE. The majority of Israel's academic institutions, including all the research universities, are financed by the state through the Planning and Budgeting Committee of the Council for Higher Education; however, sixteen of the Academic Colleges are not budgeted by this Committee, and Teacher Training Colleges are budgeted by the Ministry of Education.

According to the Council for Higher Education Law, 5718-1958, higher education institutions must receive recognition from the CHE in order to be considered an institution of higher education. The CHE also accredits institutions to award academic degrees.

Quality Assurance in Israel is carried out by the Quality Assurance and Assessment Division of the Council for Higher Education, which evaluates study programs in universities and colleges.

4.4.5 Gender equality and gender mainstreaming in research

In general, the preparation of women, via higher education, for careers in Israel is similar to that in other developed countries, where more than half of the student population is female: in Israel, this is true also for PhD students. According to data from the 2009-2010 academic year, women constituted 54.7% of BA students at Israeli universities, 57.4% of MA students and 52.7% of PhD students. The share of women among degree recipients was also above 50% at all degree levels (BA – 57%, MA – 55.4%, PhD – 50.7%).

Since recipients of a PhD degree are more like to be the supply source of researchers, it is worth noting that in 2009, the labour force participation rate of holders of a PhD degree was a very high, 88.6% (compared to a national average of 56.9% in that year) with the rate among women only marginally lower than among men (86.8% compared to 89.7%), while the national participation rate in research for women, including PhDs, was much lower than for men in 2009 – 52.3% compared to 61.7%.

In addition, the total unemployment rate among holders of a PhD degree in 2009 was a low 2.3% (compared to a national unemployment rate of 7.5% in 2009) with the rate among women holders slightly higher, at 3.6%. The share of female part-time employees with PhD degrees was higher than for males – 22.6% compared to 11.7% among males, but this female share is significantly lower than the share of part-time employees in total female employment in 2009, which was 39.6%.

Nevertheless, even though the overall picture here seems to point to equal opportunities for men and women to become researchers in Israel, the data presented are indirect, and so no clear conclusions can be drawn about women's research opportunities. There are certainly no policy regulations in place to correct any possibilities of discrimination against women in achieving research positions or to promote equal gender representation in academic and research committees, boards and governing bodies. Nor are there any regulations to guarantee the progression of female researchers with equal chances to their male counterparts, after career breaks. Paid maternity leave – for 3 months – is given primarily to mothers. Should the mother decide to take longer leave, she is entitled to do so for up to a year without losing her job, but she is not paid for the extra 9 months of leave. Men can take part but not all of a woman's statutory maternity leave.

4.5 Optimal circulation and Open Access to scientific knowledge

4.5.1 e-Infrastructures and researchers electronic identity

The government decided at the end of 2013 to establish the national initiative "Digital Israel". This project is working to formulate a national policy to promote digital economic growth, increase social welfare and reduce social inequalities through information and communication technologies. In addition, this venture is responsible for digital policy implementation while creating a coordinated and effective process, allowing the full potential of advanced technological infrastructure.

The power of the "Digital Israel" initiative creates an increase in the demand for technology and innovative developments for public use, and thus contributes to the innovative ecosystem of Technology. Thanks to the expected change in public procurement policy and government regulation, it will be easier for the public sector to

incorporate innovative systems in the areas of IT or to offer advanced technological equipment.

Furthermore, past experience has shown that the activities related to open access to government databases encourages the industry and business sector to develop innovative applications based on those databases. Therefore, the range of activities of the "Digital Israel" initiative would lead to an increase in supply from the private sector. In this way, the project will affect the entire economy – both as a supplier of technology products and services and an as a customer needing public services.

4.5.2 Open Access to publications and data

Open Access(OA) is a new initiative in Israel. There are two OA repositories in the country. The first, Israeli Scholar Works, was established in 2006 with the aim of collecting the scholarly output of Israeli studies, while the second is the Weizmann Institute of Science. As of June 2015 there are 17 OA journals published in Israel which are indexed by DOAJ. Currently, no OA policies are registered with ROARMAP. The educational and research infrastructure in Israel is strong but Open Access initiatives have not been developed, and potential barriers for the development of OA are the lack of a national mandate and an OA strategy.

MALMAD, the Inter-University Center for Digital Information Services, was set up in 1998 by the Committee of University Heads. It aims to serve as a consortium for the acquisition, licensing and operation of information services to universities and colleges in Israel. MALMAD provides modern digital information services more efficiently and at a lower cost per user through inter-university cooperation and pooling of resources.

5. Framework conditions for R&I and Science-Business cooperation

5.1 General policy environment for business

Israel ranks 53rd in the World Bank's "Ease of Doing Business Index 2016" (World Bank, 2016), as to start a business in the country takes 56 days on average. The overall distance to the frontier is 70.56 (on a range of 1-100). The country has hardly been affected by the 2008 crisis, so no insolvency regulations have been needed. In general, only one out of ten entrepreneurs are successful with their ideas in the market, but society even encourages failure as a way to become successful. In comparison with previous years, however, the situation for doing business in Israel seems to have worsened.

5.2 Young innovative companies and start-ups

The environment in Israel is highly innovative for young companies and for start ups, so it is not without reason that the country is known as the "start-up nation". (Senor & Singer, 2011).

The OCS is very aware of the need for new ideas and hence it offers pre-seed and incubators programs (see section 2 and annex 4). A good structure of funds is also offered to SMEs, although there is no specific support for one market more than another. The aim of the OCS is also not to interfere with private VC, and support mostly firms which for any reason are unable to attract investment from private markets.

The whole of the MAGNET program is structured to transfer knowledge and increase collaboration between universities and industry (for more details, see section 2.2). At the public level there are a number of well-structured fora in big cities, such as Tel Aviv, Jerusalem and Haifa, where young entrepreneurs and experienced ones meet together on a regular basis, once or twice a month, to discuss ideas while drinking a beer that is normally sponsored by a private company. The country is very small and so the network of innovators is dense and well connected.

5.3 Entrepreneurship skills and STEM policy

Israel is among the leading countries in academic research, industrial and military research and development, and high-tech innovation. Yet Science, Technology, Engineering and Mathematics (STEM) education is compromised due to weak infrastructure, high student-to-teacher ratios, and small budgets (JCF, 2013).

One challenge to Israel's STEM potential is that many of Israel's *haredi* (ultra-orthodox) have not participated in STEM education or its workforce to date. Fortunately, many companies and programs are emerging to integrate ultra-orthodox men and women into these sectors with great success, particularly given the keen and well-established analytical skills which the ultra-orthodox have developed through their Torah studies. A unique step in Israel's STEM pipeline is compulsory military service for 18-year-olds. This minimum of 2 years of service for women and 3 for men provides skills and a work culture that instill innovation and entrepreneurial capabilities, but it also delays entry into the workfore.

The OCS has launched some research and formed a committee directed by Eugene Kandel, the Chairman of the Israeli National Economic Council, and has concluded that there is a shortage in Israel of highly qualified workforce. The steering committee recommended tackling the problem through a major operation on two fronts:

- Reduce the gap between demand and supply of skilled workers in the employment market, by targeted actions

- Expand the scope of high school studying technology trends and encourage young people to choose academic studies in high-tech fields.

Therefore a series of measures have been taken with different time spans: In the long term: it was recommended to find tools that encourage scientific excellence in education, and in particular the significant expansion of the Ministry of Education's program of scientific-technological reserve. Other recommendations deal with the increasing supply of a relevant professional teaching force, further developing the use of digital platforms, and expanding programs for gifted students.

In the medium term: the Commission recommended programs that increase access to higher education in engineering and science for people who do not currently meet the criteria for acceptance of these professions in academia. In addition, a program directed towards specific target populations:

- The Arab sector: these days the program has begun integrating Arab society into high-tech industries formulated by the Office of the Commissioner for Employment. The program's objective is to locate students and academics from the Arab population, starting with high-tech industry, and offer them personal guidance, training and placement assistance, thereby creating a network of contacts at the beginning of their careers.
- *Haredi* (ultra-orthodox) population: the committee introduced a pilot program called "*Talpiot Haredim*", aimed at training high-quality small groups of outstanding young people anxious to integrate in the society. This group would constitute an elite group that would lead the integration of the ultra-orthodox community in the Israeli high-tech industry and help to generate a broader process of integration into the high-technology sector. This program is currently under development.

In the short term: the Commission recommends, among other things, the formulation of a plan to refresh the knowledge of experienced engineers who are not currently working and who have the potential to develop programs to update Israeli academicians living abroad.

To address these challenges requires a long and steady activity, and therefore, in addition to the recommendations above, the Committee intends to establish a steering committee headed by the Commissioner of Labor and Chief Scientist, and attended by representatives of ministries and relevant agencies. The purpose of the team will follow the progress of implementing the recommendations and implementing them, coordinate activities and initiate additional programs, among others on the integration of women in high-tech. All this is an alongside ongoing consultation with the relevant employers.

5.4 Access to finance

In 2014 a peak was reached for Israeli high-tech companies, as they managed to raise € 2.56 bn. and made a hundred exits worth about seven billion dollars, including mergers and acquisitions to approximately € 3.61 bn., and IPOs about € 1.58 bn. Israeli venture capital funds raised € 688 m. this year, an increase of 68% compared with 2013, and the highest recruitment in the past six years. Investments of Israeli venture capital funds into local high-tech companies stood at € 432 m. in 2014.

Reduction of base turnover - an approved enterprise (prior to Amendment No. 60) and a beneficiary enterprise are entitled to reduce their base turnover by 10% in each tax year starting from the record year, provided they meet certain cumulative conditions regarding the rate of R&D expenses, the percentage of employees with academic qualifications in engineering, computers, life sciences or exact sciences, and products replacement or investments in productive assets. The benefit is contingent on demonstrating the enterprise's compliance with the base turnover reduction criteria pursuant to Regulation 1 of the Regulations for Encouragement of Capital Investments (Reduction of Base Turnover). Among others, Regulation 1 states that the total R&D expenses incurred by an enterprise in a tax year in respect of which the OCS approval

was obtained, or in the preceding year, will not be lower than 7% of the turnover in the tax year and the preceding year.

Section 20a to the Income Tax Ordinance allows the deduction for tax purposes of a company's R&D expenses incurred for the purpose of promoting and developing the company. According to this section, under the conditions prescribed therein, expenses incurred in scientific research in industry, agriculture, transportation or energy approved by the OCS will be deductible on a current basis in the tax year in which they are paid. As for expenses incurred in scientific research which are not approved by the OCS, these will be deductible in three annual installments starting from the tax year in which they are paid.

From a deeper reflection on the financing needs of technological companies in Israel it is evident that the current business environment allows sufficient financing support to companies at early stages. This is leading to the establishment of many new start-ups. As a result, there is some "inflation" of seeds and a major recruitment stage at Round A, which is characterized by a marked increase in the financing needs of companies and the supply of capital being concentrated in the hands of venture capital funds. On the other side of the fence, there is a trend in recent years beyond the strategy of "big bets": in other words, investing large amounts of money in few companies rather than diversifying the investment in a smaller number of companies. In this way, the supply of capital is small compared to the number of companies seeking to recruit funding especially given the excess demand for financing previously described. A shortage of funds makes it difficult to integrate many companies and to raise funds for all of them to continue operations, forcing them to shrink and sometimes to close ("Series A crunch"). This phenomenon was the catalyst for the establishment of funds focusing on early stage investments (micro VC) that is starting to happen today in Israel. This means there is a stage funding gap which in Israel is estimated to be around € 100-200 m.

5.5 R&D related FDI

Israel's success in technology and innovation is attracting investors from around the world and especially in the field of venture capital. In recent years, the presence of foreign funds in Israel has been growing stronger and subsequently is increasing the dependence of Israeli high-tech companies on foreign capital. To put this fact in perspective, during 2013 foreign investors financed 75% of all investments in Israeli companies and about 85 % of total capital raised by Israeli venture capital funds. In fact, foreign funding accounts for about half of the total funding for R&D in Israel (see Table 2). Most of the foreign capital invested in Israeli venture capital originated in the United States, but the last three years have shown a growing interest from investors from Asia, especially from China.

The inflow of foreign investment contributes significantly to the growth and R&D activities of the high-tech economy. However, reliance on foreign sources reveals local industry fluctuations and crises in the global market, and at a time of crisis, foreign investors might reduce their investments in markets far away, as was the case during the financial crisis in 2008 when investments in Israeli high-tech dropped by 50%. In view of this, it is vital to create local financing alternatives, especially so as to make the stock market an attractive alternative and an efficient way to raise capital through technology companies.

5.6 Knowledge markets

Israel has a well-developed intellectual property system, which underpins the country's status as one of the most innovative economies. A significant development in Israeli intellectual property law is the introduction of the Copyright Act 2007, which, inter alia, replaced the doctrine of fair dealing by that of fair use, thus providing a more flexible approach to copyright exceptions – an exceptional step which few jurisdictions have taken so explicitly. Israel has also reached an agreement with the United States to

amend certain pharmaceutical IPR provisions relating to patent-term extension, patent-application publication, and data exclusivity (WTO, 2012)

5.7 Public-private cooperation and knowledge transfer

Israel has a 3.3 % share in public-private publications, more than double the European average of 1.8%. In 2012, private funding for public R&D was 1.42 % of the GDP in Israel, slightly above the EU average of 1.1 %.

The main public knowledge transfer is done through MAGNET (the acronym in Hebrew for Generic Pre-Competitive R&D) programs. These programs encourage collaboration among industrial companies and between companies and researchers from academic institutions through several instruments. These instruments seek to develop Israel's industrial infrastructure by supporting R&D activities and sharing technological knowledge among its participants. Some of the main istruments are[8]:

- **Magnet Consortia:** This program supports the formation of consortia made up of industrial companies and academic institutions in order to jointly develop generic, pre- competitive technologies.
- **Magneton:** The program promotes technology transfer from academia to industry via mutual cooperation between an individual company and an academic research group, reducing the firm's uncertainty regarding the use of novel technology.
- **Users Association:** An "Advanced Technologies Users Association" is a group of industrial companies involved in the dissemination and assimilation of generic advanced technology and in the sharing or utilizing of a common technology. This instrument also enables the creation of a demonstration site for the service of the association's members in their development activity.
- **Nofar – Industrial Application of Academic Research:** The program is designed to bridge the gap between know-how within academia and the needs of the industry. It does so by encouraging the support of applied academic research activity by an industrial company(already commented on in Section 2.2).
- **Kamin -** The program is designed to translate academic research achievements into technologies of interest to the Industry. It serves as an additional bridge between pre-commercial research and industrial research.
- **Telem Forum** is a voluntary partnership between The Office of the Chief Scientist in The Ministry of Economy, The Office of The Chief Scientist in The Ministry of Science & Technology, The Planning and Budgeting Committee of the Council for Higher Education the Ministry of Defense and the Ministry of Finance. TELEM encompasses several programs aimed at establishing a national infrastructure for R&D in areas that are of common interest to the forum's members.
- **Tzatam** This TELEM instrument is designed to assist experienced companies who provide research services in the field of Life Sciences by supporting the purchase of expensive equipment, thus strengthening Israel's Life Sciences R&D capabilities. These purchases provide entities in both industry and academia the ability to broaden the scope of the research they conduct. OCS equipment purchase grants assist in the validation of scientific and technological feasibility and in the receipt of approvals to perform clinical trials.
- **Basic and Applied Nanotechnology Research:** From 2005 to 2012, six nanotechnology academic research centers have been founded and put into operation in Israel: first at the Technion, then Tel Aviv University, Hebrew University, Bar-Ilan University, Ben-Gurion University, and The Weizmann Institute. The program has established strong capabilities in design and fabrication of nanodevices which has aided research in academia and development in industry. A follow-up program has been devised for 2012-2016, the main goal of which is to establish a strong

[8] In section 2.2, the recents developments (those implemented in the last three yeears) concerning these programs have been discussed. Here there is a more general overview, including older programs.

Nanotechnology industry by transferring technologies from academia to industry and by creating a pool of skilled Ph.D. and an M.Sc. graduates in Nano-science.

- **National Bio-Bank:** A bio-bank is an organized collection of human biological material and associated information stored for one or more research purposes. Bio-banks allow researchers to analyze data representing larger numbers of individuals than to which they would typically have access, thus profoundly improving the efficient use of biological information and hastening new medical discoveries. The State of Israel, having realized the importance of such a repository to the advancement of medical innovation, has founded a national bio-bank. Through The Office of the Chief Scientist of the Ministry of Economy and Trade, The Office of The Chief Scientist of the Ministry of Science & Technology, The Planning and Budgeting Committee of the Council for Higher Education and The Ministry of Finance
- **Support for Israeli Research Institutions:** This program assists research institutions with clear links to industry in strengthening their technology infrastructure and developing relevant technologies and products.
- **Long-Term R&D Support for Large Companies with Substantial R&D Investment:** This program is designed to encourage long-term R&D. (see section 2.2 for more details)
- **National Institute for Biotechnology in the Negev (NIBN) :**The NIBN was established within Ben-Gurion University in 2005 with the co-investment of several government entities, including the OCS, to create a more effective multidisciplinary bridge between basic and applied research in biotechnology and for the emergence of a successful biotechnology industry in Israel and the Negev. The focus of the institute's research includes structural biotechnology, computational biotechnology, human genetics, functional genomics, nanomedicine and immune system biotechnology.

Israel has a well designed program for technological Incubators. The primary goal of this program is to transform innovative technological ideas in their early, high-risk stages into viable startup companies capable of raising money and operating on their own. Additional goals of the program are: promote R&D activity in peripheral and minority areas, create investment opportunities for the private sector, including venture capitalists, transfer technologies from research institutes and implement them into the industry and enhance the entrepreneurial culture in Israel. The program is subject to the R&D law with regards to manufacturing, royalties and IP rights.

Another interesting initiative is Academitech. It is a competition at the student level established by the OCS, for the development of an innovative product. The competitors are groups of students from institutions recognized by the Council for Higher Education that will present a Proof of Concept for a commercial product. Any field of study is eligible to enter the competition. Academitech is a competition at the student level established by the OCS, for the development of an innovative product. The competitors are groups of students from institutions recognized by the Council for Higher Education that will present a Proof of Concept for a commercial product. Any field of study is eligible to enter the competition.

Israel, as the 'Startup Nation', is well known for its entrepreneurial spirit, which is also well reflected in the different types of accelerator programs, although private funded, that have been launched in the past three years. The most important part of an accelerator, besides the mentors and the funding (through VC) as an entrepreneur from any program, is the fact that many of them offer a shared space. As most of the startups are going through the same difficulties, this is the best way to make sure that they really work harder on the achieving their goals. It is also the best place for mutual brainstorming sessions, problem sharing , self-discipline, focus and the most important – solution sharing. The impact of the accelerator on startups has been huge.

National Institute for Biotechnology in the Negev (NIBN) :The NIBN was established within Ben-Gurion University in 2005 with the co-investment of several government entities, including the OCS, to create a more effective multidisciplinary bridge between

basic and applied research in biotechnology and for the emergence of a successful biotechnology industry in Israel and the Negev. The focus of the institute's research includes structural biotechnology, computational biotechnology, human genetics, functional genomics, nanomedicine and immune system biotechnology.

5.8 Regulation and innovation

In Israel, no specific research has been carried out covering the impact of regulation and innovation. Although the country has high levels of bureaucracy, it seems to find ways to be among the leaders in innovation.

5.9 Assessment of the framework conditions for business R&I

The framework conditions are in place to lead to successful investment in Israel. The country has a highly qualified population, with a high proportion of entrepreneurs, and a vibrant academic environment that cooperates with industry, and all of this creates a successful environment for business. The only weakness of the system is that it is highly dependent on foreign investment.

6. Conclusions

6.1 Structural challenges of the national R&I system

The Israeli research and innovation system faces three serious structural challenges, stemming both from internal factors and from shifts in the global marketplace. These are long-term challenges that pre-date the global economic crisis that started in 2008, even though the crisis may have highlighted their urgency, and they require the kind of long-term responses that helped the Israeli research and innovation systems excel in the previous two decades.

Like most structural challenges, these ones are extensively interrelated and touch on many other issues of concern to policymakers, but they are distinct enough to outline separately as follows:

1. Making up for the "lost decade"

Investments in Israeli higher education and research essentially stagnated during the first decade of this century. From 2000 to 2010, budgets effectively declined compared to the growth in population. By the middle of that decade, investment per student had declined by 9% compared to 1995 and the average age of faculty in exact science departments was over 55. Investment in research infrastructures also fell behind, forcing universities to rely mainly on donations.

In output terms, the first results could be seen by the end of the decade in the decline in the country's share of world scientific publications, which declined from 1.1% in 2000 to 0.9% in 2009, proportionately a radical decrease for a small country highly dependent on research and innovation. As far as citation impact is concerned, the decline was less acute, from 12th to 13th place worldwide, according to a study of Israeli scientists' publications (Samuel Neaman Institute, 2011). The lower drop in citation index rankings was attributed to the impact of papers of older researchers many of whom have reached retirement age.

As a result of this stagnation, the brain drain became an acute problem. However, by the end of 2015, the number of academics living abroad had slowed to a halt. It had remained steady between 2012 and 2014, after an increase of 19% between 2010 and 2012 during the height of the social protests in Israel, according to a survey conducted by the Israel National Brain Gain Program and released by the Ministry of Economy and Trade.

2. Heavy Reliance on ICT

The Israeli economy is heavily reliant on ICT based exports and clusters of industries based on a deep pool of talent that stretches from academe to small ICT based start-ups. The Israeli economy offers a fascinating illustration of extraordinary success in innovation, particularly in Information and Communications Technologies (ICT), which came largely as a result of a concerted, long term strategy of government support for commercial R&D, which levered the potential of a highly skilled labor force. Yet, the benefits from the rapid growth of the High Tech sector eluded the rest of the economy, thus giving rise to a "dual economy": a high rate of growth for ICT and a mediocre growth rate for the economy as a whole. (Trajtenberg 2006)

The success of ITC industry is what enabled Israeli R&D based industries to attract substantial investment from business in ICT-based industries, and this in turn was one of the reasons for the reduction in total government support of business-based R&D by 36.3%[9] compared to inflation adjusted prices in the year 2000.

Policymakers have been aware of this situation for years, and have been encouraging Israeli industry to diversify through a variety of measures and initiatives. Yet they face a

[9] Statement by Avi Hasson, Chief Scientist in the Ministry of Economy and Trade, October 2011

challenging dilemma: an in-depth study[10] has proven that government support of mainly ICT-based industries is critical for economic growth in a highly competitive world, even though the majority of funding for innovation comes from the business sector. This means that a decision to divert a major part of the government resources intended to support industrial R&D to other new fields would cause extensive economic damage. Technology-based exports, predominantly based on ICT, account for close to half of Israeli exports. There are no data on exactly what percentage of these exports are based on government support programs, but by definition, government support is extended to the riskiest R&D ventures, those that give Israeli ICT exporters their competitive edge. Hence, diversion of resources from ICT would deprive Israeli industry of an important element of its competitive capacity.

Yet not diversifying is also not seen as a good long range option (Trajtenberg, 2006). The overall returns on the heavily ICT-based Israeli venture capital industry have been disappointing during the past decade. Since a major part of the Israeli innovation system is predicated on creating new ICT companies, this is a strong indicator that the innovation system needs new engines of growth.

In the past decade, the government largely abandoned the field of thematic university-based research in all civilian fields except for agriculture, and most of the thematic research conducted in Israeli universities is through the country's participation in the EU Framework Programs. Extensive thematic research is carried out in Israel's large and classified defense R&D system, and there is anecdotal evidence[11] of major spill-over effects onto the civilian-based ICT innovation system. This successful example shows that developing new areas of expertise requires not only extensive human and physical infrastructures, but also a judicious mix between thematic academic research and project-oriented R&D. Hence, the challenge to develop non-ICT based innovative industries must be cast not only in terms of industrial policy, which is managed by the OCS in the Ministry of Economy and Trade (OCS), but also in terms of research policy managed by VATAT and by the Israeli Science Foundation.

3. VC Environment

Venture Capital is an essential part of the Israeli innovation system. To put things in proportion, the total annual investment by VC in Israeli technology start-ups during the past decade has usually been at least four times higher than the total government budget to support innovation in all firms from start-ups to major corporations.

In 2014, 12 Israeli venture capital funds raised € 688 m., the highest quantity raised by such funds in six years. The year's fund increased by 68 % from the € 409 m raised by 11 VC funds in 2013, and was 18% above the 10-year average of € 585 m.

Four veteran Israeli VC funds managed to raise more than € 75 m. each and accounted for 64% of total capital raised in 2014. Carmel Ventures' fourth fund attracted the largest amount – € 146 m., and the average fund size in 2014 reached € 57 m. The increase reflects the raising of more medium-sized funds and fewer micro VC funds than in each of the previous two years. During the 2011-2014 period, micro venture capital funds – managing capital below € 37 m. – accounted for 14% or € 330 m. of the total amount raised by venture capital funds. However, the micro VC trend seems to have abated, as only three new funds were established in 2014, compared to an average of nine over the previous three years.

[10] Lach, Wasserteil., & Prizant, 2008
[11] Eilam, 2011

Table 4: Policy measures and assessments

Challenges	Policy measures/actions	Assessment in terms of appropriateness, efficiency and effectiveness
Redressing the "lost decade" in academic research	1. Six-year VATAT plan, increasing research budgets and retaining more researchers 2. I-CORE programs for centres of research excellence	The program to repair and renew academic research appears to be both appropriate and comprehensive, and it seems at least to have halted the decrease in the number of academicians in Israel.
Over reliance on ICT-based innovation	1. OCS programs encouraging R&D in new fields including traditional industry. 2. Government participation in dedicated biotech VC fund.	OCS programs are generally effective in addressing their immediate target. However, the OCS cannot devote more of its limited budget devoted to non-ICT commercial R&D because the funds are needed by proven generators of jobs and wealth in ICT. The drive to diversify must go far beyond the immediate target of reducing the risk of commercial R&D. If the I-CORE programme does indeed produce both the knowledge and human skills needed to develop new fields, this is only part of the infrastructure needed for diversification.
Precarious state of Venture Capital	Government measure to insure 25% of the risk of Israeli institutional investors who join funds as limited partners	It is still early and difficult to assess but there is a positive reaction from the Israeli VC industry in terms of the volume of funds raised.

6.2 Meeting structural challenges

Two of the three challenges outlined above – the quality of university research and the precarious status of Israeli venture capital – have been addressed by actions intended to directly mitigate the problems in the country's research and innovation systems. The third challenge – the need to diversify the ICT-centric technology sector – has been addressed by a variety of measures, but this is a long-term and complex challenge that defies simple solutions.

It is early to assess the effectiveness of the six-year VATAT plan (2011-2017) and the I-CORE programme. In 2015 the first indicators of success were that the brain drain seems to have stopped. New researchers are being retained by universities and the number of researchers returning to Israel to join I-CORE programs has increased.[12] However, the real tests of the programme will be in general academic quality, as measured both by bibliometric and other indicators, and by the commercial technologies that result from this basic research. Both of these will take a long time to materialize. There has been some criticism in academic circles of the I-CORE åprograms, with academics saying that the preferred status of I-CORE centres will be at the expense of other academic researchers. Yet so far there is little evidence to support this claim. In general, the response to the challenge of the "lost decade" seems comprehensive and integrative, especially since it does not seek to turn the wheel back but to create a research environment suited to the conditions of the 21st century.

As reported above, the large venture capital sums attracted by Israeli high-tech firms (€2.40 bn. in the first 9 months of 2015) can be interpreted as a positive reaction by the Israeli VC industry towards the government policy. However, the effectiveness of the response depends on so many extraneous factors that it is hard to judge on its own merits. Israeli institutional investors, like their colleagues in other countries, are judged

[12] At the end of 2015 there was still no information on the effectiveness of those plans.

by harsh criteria, such as performance per quarter. The decision about whether to lock up capital for seven to ten years because of the government's commitment to underwrite part of the risk depends to a large extent as much on current market conditions as on strategic considerations about the composition of each investor's portfolio. If Israeli investors are choosing to enter the programme, this is only one part of each fund management company's struggle. They then have to persuade investors abroad, who should make up the majority of each limited partnership, to invest in their fund, despite the current tumultuous state of capital markets.

The challenge of diversification beyond ICT is both more complex and more intriguing. Proof that it is achievable can be seen in the development during the past decade of a substantial cluster of Israeli companies in the field of medical devices, which is based on the skills and entrepreneurial drive of researchers and technologists from a broad range of fields ranging from medicine to ICT. However, even if the various measures promulgated and enacted by the OCS from biotechnology through nanotechnology to cleantech are successful, and if the I-CORE programme does indeed lead to the development of skills needed for the next generation of technologies, this might not be enough. The various clusters of Israeli companies in ICT are predicated on two additional conditions. The first is markets in a state of rapid growth in which relatively small Israeli companies can make their mark. The second is the existence of a financial ecosystem that can develop these companies. Even if these issues have not been resolved now, it is clear that various government initiatives, if seen in concert, are trying to address the complexities of this problem.

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Abbreviations

BERD	Business Expenditures for Research and Development
CERN	European Organisation for Nuclear Research
CHE	Council for Higher Education
COST	European Cooperation in Science and Technology
EPO	European Patent Office
ERA	European Research Area
ERA-NET	European Research Area Network
ERC	European Research Council
ESA	European Recovery Programme Fund
ESFRI	European Space Agency
EU-28	European Union of 28 Member States
FDI	Foreign Direct Investments
FP	European Framework Programme for Research and Technology Development
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations on R&D
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HEI	Higher Education Institution
HERD	Higher Education Expenditure on R&D
HES	Higher Education Sector
IP	Intellectual Property
ISF	Israel Science Foundation
M&A	Mergers and Acquisitions
OCS	Office of the Chief Scientist, Ministry of Economy
OECD	Organisation for Economic Co-operation and Development
PRO	Public Research Organization
R&D	Research and Development
RDI	Research Development and Innovation
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
S&P	Standard and Poor
S&T	Science and Technology
SF	Structural Funds
SME	Small and Medium Sized Enterprise
VATAT	Hebrew acronym for the Planning and Budgeting Committee of the Council for Higher Education
VATAT(Hebrew)	ותקצוב לתכנון וועדה

VC	Venture Capital

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Annexe 1 - List of the main research performers

TOP 10 based on publications

1. Hebrew University of Jerusalem
2. Tel Aviv University
3. University of Haifa
4. Ben-Gurion University of the Negev
5. Technion - Israel Institute of Technology
6. Weizmann Institute of Science
7. Bar-Ilan University
8. The Interdisciplinary Center
9. Bezalel Academy of Arts and Design
10. The College of Management – Academic Studies

TOP 10 firms based on R&D doers

1. TEVA PHARMACEUTICAL INDUSTRIES
2. ELBIT SYSTEMS
3. IAI
4. MELLANOX TECHNOLOGIES
5. NICE-SYSTEMS
6. CHECK POINT SOFTWARE TECHNOLOGIES
7. ORBOTECH
8. STRATASYS
9. CERAGON NETWORKS
10. RADWARE

Annexe 2 - List of the main funding programmes

Name of the funding programme	Timeline	Budget	Target group
Large Companies' R&D Centers in Israel's Periphery	2-3 years	€ 321 m. (annual)	Big Companies.
Support for Traditional Industry	permanent		Mature SMEs.
Encouragement of R&D in Space Technologies	permanent		Seed companies. Mature SMEs. Big Companies.
Industrial R&D in Agriculture	permanent		Seed companies. Mature SMEs. Big Companies.
MEIMAD - Encouraging R&D of Dual Use Technologies	30 months		Seed companies. Mature SMEs. Research Institutes and Academia.
Development of Technological Solutions for People with Special Needs	permanent		Pre-seed companies. Seed companies. Mature SMEs.
Israeli National Renewable Energy Center – Testing and Validation Track	permanent		Seed companies. Mature SMEs. Big Companies.
R&D preparatory Program for Traditional Industry	permanent	n.a.	Mature SMEs.
KIDMA Advancement of Israeli Cyberspace	permanent	n.a.	Pre-seed companies. Seed companies. Mature SMEs. Big Companies.
Assistance of Seed Companies	permanent	n.a.	Pre-seed companies. Seed companies.
Tnufa	permanent	n.a.	Entrepreneurs. Pre-seed companies.
Technological Incubators	permanent	n.a.	Entrepreneurs. Pre-seed companies.
Biotech Designated Incubators	permanent	n.a.	Entrepreneurs. Pre-seed companies.

Technological Based Industrial Incubators	permanent	n.a.	Seed companies.
Israeli National Renewable Energy Center Venture Track	permanent	€ 12 m	Entrepreneurs. Pre-seed companies. Seed companies.
Life Sciences VC Fund	10 years	€ 165 m	Pre-seed companies. Seed companies. Mature SMEs.
Investment in VC-Backed Companies in the field of Alternative Fuels for Transportation	9 years	€ 75 m	Pre-seed companies. Seed companies. Mature SMEs. Foreign Companies. Direct Investors.
Reduction of Greenhouse Gas Emission	permanent	n.a.	Seed companies. Mature SMEs. Big Companies. End Users.
Institutional Investment in Israeli High Tech	permanent	n.a.	Direct Investors.
MAGNET Consortia	permanent	n.a.	Pre-seed companies. Seed companies. Mature SMEs. Big Companies. Research Services Companies. NGOs. Foreign Companies. Research Institutes and Academia. End Users.
MAGNETON - Encouragement of Technology Transfer from Academia to Industry	permanent	n.a.	Mature SMEs. Big Companies. Research Institutes and Academia.

NOFAR - Industrial Application of Academic Research in The Fields of Nanotech and Biotech, Medical Devices, Water and Energy	1.5 years	€ 105.000	Seed companies. Mature SMEs. Big Companies. Foreign Companies. Direct Investors. Research Institutes and Academia.
KAMIN - Promotion of Selected Applied Academic Research	permanent	n.a.	Research Institutes and Academia.
Users Association	permanent	n.a.	Seed companies. Mature SMEs. Big Companies. End Users.
TZATAM Equipment Purchase Grants for Life Sciences Research	3 years	€ 7 m	Research Services Companies. Research Institutes and Academia.
Basic and Applied Nanotech Research Support	7 years	€165 m	Research Institutes and Academia.
National Biobank	5 years	€ 7.5 m	Pre-seed companies. Seed companies. Mature SMEs. Big Companies. Research Services Companies. NGOs. Foreign Companies. Research Institutes and Academia.
Isragrid	Permanent	n.a.	Pre-seed companies. Seed companies. Mature SMEs. Big Companies.
Support for Long-Term R&D of Large Companies with Substantial R&D Investment	Permanent	n.a.	Big Companies.
Support for Israeli Life Sciences and Traditional Industry Research Institutes	Permanent	n.a.	Research Institutes and Academia.

Israeli National Renewable Energy Center - Research Track	Permanent	n.a.	Research Institutes and Academia.
NIBN National Institute for Biotechnology in the Negev	Permanent	n.a.	Research Institutes and Academia.
Bi-National Agreements	Permanent	n.a.	Pre-seed companies. Seed companies. Mature SMEs. Big Companies.
Bi-National Funds USA, Canada, China, Korea	Permanent	n.a.	Pre-seed companies. Seed companies. Mature SMEs. Big Companies.
The Global Enterprise R&D Cooperation Framework	Permanent	n.a.	Seed companies. Mature SMEs. Big Companies. Foreign Companies.
Program to Encourage the Establishment of R&D Centers in Israel for The Service of The International Financial Community	Permanent	n.a.	Foreign Companies.
Project Centers for Multinational Companies	permanent	n.a.	Seed companies. Mature SMEs. Big Companies. Research Services Companies. Foreign Companies. Research Institutes and Academia.
EU Framework Program	permanent	n.a.	Entrepreneurs. Pre-seed companies. Seed companies. Mature SMEs. Big Companies. Research Services Companies. NGOs. Research Institutes and Academia. End Users.

EUREKA-Eurostars	permanent	n.a	Seed companies. Mature SMEs. Big Companies.
EEN Enterprise Europe Network	permanent	n.a	Entrepreneurs. Pre-seed companies. Seed companies. Mature SMEs. Big Companies.

Annexe 3 - Evaluations, consultations, foresight exercises

In Israel two main foresight exercises were conducted in 2014-2015:

The first exercise was by the OCS, as analyzed in the text in section 2.2.1 . It can be accessed online (OCS, 2015) though unfortunaly only in Hebrew.

The second was by the central bank of Israel. However, it is much more general, as it applies to the whole economy, employment, debt, and monetary policy and therefore it was far from the thematic of the current paper, and so was not introduced into the discussion. It can be accessed online in English (Bank of Israel, 2013b).

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